30c. a Copy—$3. a year. DECEMBER, 1895. Volume X. No. 3.

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THE ENGINEERING MAGAZINE

·AN·INDUSTRIAL·REVIEW·

EDITED BY JOHN R. DUNLAP.

FIRST PRINCIPLES IN MONEY AND BANKING—
Our Currency Problem in the Light of American History. HORACE WHITE. 391

SIDE LIGHTS ON THE SOUTH AFRICAN GOLD BOOM—
An Unprecedented Chapter in Speculative History. ALBERT WILLIAMS, Jr. 399

THE DISTRIBUTION OF ELECTRIC POWER AT NIAGARA—
With Estimates of Cost as Compared with Steam. FRANKLIN LEONARD POPE. 407

THE EDUCATION OF MECHANICAL ENGINEERS—
I. Aim and Scope of the Engineering Colleges. R. H. THURSTON. 418
II. The Bearing of Shop Practice. CHARLES E. EMERY. 423
III. Value of Manual Training Schools. A. E. OUTERBRIDGE, Jr. 428

INVESTIGATION OF PUBLIC WATER SUPPLIES—
Expert Suggestions as to the Best Methods. FLOYD DAVIS. 439

THE GREAT MODERN TRANSATLANTIC STEAMERS—
III. Era of Steel Construction and Multiple-Expansion Engines. S. W. STANTON. 447

THE COST OF MODERN RAILROAD CONSTRUCTION—
Effects of Improved Methods and New Conditions. J. F. WALLACE. 472

SCHOOLS AND SCHOOL HOUSE ARCHITECTURE—
Purpose, Design, Location, Drainage, Ventilation, etc. E. C. GARDNER. 478

THE MANUFACTURE OF STEAM—
Some Important Investigations now in Progress. A STAFF WRITER. 500

Review of the Industrial Press—

With an Index to the leading articles published currently in the engineering journals of the United States and Great Britain.

ARCHITECTURE AND BUILDING, . 505
CIVIL ENGINEERING, . . . 513
DOMESTIC ENGINEERING, . . . 521
ELECTRICITY, ... 526
INDUSTRIAL SOCIOLOGY, . . 535
MARINE ENGINEERING, . . . 543
MECHANICAL ENGINEERING, . 548
MINING AND METALLURGY, . . 557
MUNICIPAL ENGINEERING, . . 567
RAILROADING, ... 573
SCIENTIFIC MISCELLANY, . . 584
BOOKS OF THE MONTH, . . 592

IMPROVED MACHINERY, 597

FOR INTRODUCTION TO AUTHORS, SEE PAGE 5.

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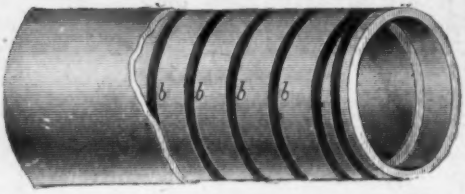

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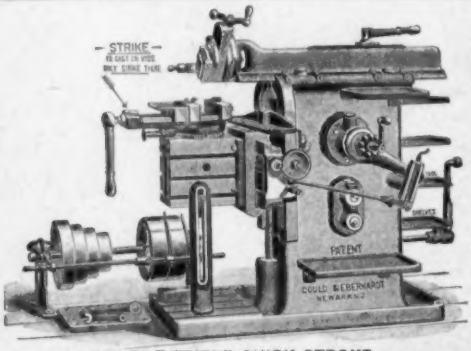

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THE

ENGINEERING MAGAZINE

VOL. X. DECEMBER, 1895. NO. 3.

MONEY AND BANKING.*

By Horace White.

I.—FIRST PRINCIPLES AND THE GOLD STANDARD.

ON the 25th of February, 1862, the government of the United States made its paper evidences of debt legal tender between individuals. The nation was thus sent upon the wrong road, and has been toiling in a wilderness ever since. In addition to the injustice which it wrought, the legal-tender act filled the public mind with misconceptions and delusions on the subject of money. So it came to pass that, although we adopted irredeemable paper with the greatest reluctance, we were willing to flounder in it 14 years after the supposed necessity for it had passed away. Then, partly by design, partly by chance, we resumed specie payments; but the people had, to a large extent, lost sight of the fundamental principles of money. The misconceptions and delusions remained, the most dangerous and widely prevalent being the notion that mere quantity is a desirable thing, and that the government can produce quantity and ought to.

It is the aim of this work to recall attention to first principles. For this purpose it has been deemed best to begin at the beginning of civilized life on this continent, and to treat the subject historically. The science of money is much in need of something to enliven it. If anything can make it attractive, it must be the story of the struggles of our ancestors with the same problems that vex us. The reader will find an abundance of these in the following pages. Indeed, a complete and correct theory of money might be constructed from events and experiences that have taken place on the American continent,

* Mr. Horace White, the distinguished economic writer, and editor of the New York *Evening Post*, has just published, through Messrs. Ginn & Co., Boston and London, a

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even if we had no other sources of knowledge. This may be said of the science of banking also. All the wisdom and all the folly of the ages, as to these two related subjects, have been exploited on our shores within the space of less than 300 years.

Very few persons, if any, are satisfied with our present monetary condition. While I write these lines, a withdrawal of $2,350,000 gold from the treasury causes a fresh tremor and confusion of tongues. Everybody assures everybody else, and tries to assure himself, that it is of no consequence. Probably no harm will come of it; but why should it be noticed at all, except by a few dealers in foreign exchange? Because the public treasury undertakes to maintain the ultimate gold reserve of the country, and because people doubt whether it can do so at all times. Are these doubts unreasonable?

Suppose that the government were out of the banking business altogether, its fiat money retired, and the treasury restricted to its normal and proper business of collecting and distributing public revenue. In that case the duty of redeeming the paper circulation and maintaining a sufficient gold reserve for the purpose would devolve on the banks, and would be discharged automatically. The banks would learn by experience how large a reserve is required generally. In emergencies, when, for any reason, more should be required, they would obtain the means from their maturing bills receivable. This would come to them either in the shape of their own circulating notes, thus lessening the call upon them for gold, or in gold itself, which the mercantile community would be obliged to procure and send in to them. Of course this implies a curtailment of discounts, but curtailment is not avoided under the present system. The curtailment in the panic of 1893 was as severe as it could ever be if the banks were solely

small volume entitled "Money and Banking," which is destined to play a very important part in the solution of the currency problem in the United States. The whole monetary history of the American continent is graphically set forth in chronological order; the facts of our experience are paralleled by the experience in other civilized countries; every page of the text is characterized by bold side-heads in black type, rendering it invaluable for reference; there is a complete absence of the technical terms and mystifying logic which usually burden discussions of finance; and, in addition to an appendix of valuable facts and a list of the vast number of important books and pamphlets consulted in the preparation of the work, an excellent index is given in the rear of the volume. Not alone the most important contribution to the literature of the subject up to date, it may be fairly described as a classic in the literature of finance, destined to exert a healthful influence for generations to come.

Rather than attempt any original review of the work, it has been thought best to permit Mr. White to speak for himself. We therefore present a series of quotations designed to present an outline of the author's argument. The first instalment is devoted to "First Principles and the Gold Standard," and the second will be devoted to "Representative Currency and Banking." From them our readers can form a fair general idea of Mr. White's argument; but it is scarcely necessary to say that this will not be sufficient for the man of intelligence who desires to be *thoroughly* well-informed. Indeed, this is a book which should find a place in the library of every intelligent reader of these pages, for we can never hope for uninterrupted progress in constructive enterprise until the money question is finally and rightly settled.—THE EDITOR.

responsible for the redemption of the paper circulation. But probably there would have been no panic at all at that time, if the government had been restricted to its proper business, and had not been issuing fiat money in large quantities.

It is thus apparent that the first step toward a rational system is the retirement and cancellation of the legal tender notes and the restriction of the treasury to the duties for which it was originally and solely designed. When this is done, the public mind will be so cleared that other reforms, and especially banking reform, may be hopefully undertaken.

My opinion is that the Scotch bank system is the best in the world, and that we might borrow from it, as the Canadians have done, to our advantage. There are only ten banks in Scotland, but they have nearly one thousand branches, reaching every hamlet in the nation. Deposits are received and loans are made at each branch, but the branches pay out only the notes of the bank, which are redeemable at the head office. So it is necessary to have real money only in one place, instead of perhaps one hundred different places. At the branches the bank's circulating notes answer the purposes of retail trade, while checks drawn against deposits answer all other purposes. Thus the maximum of business is done with the minimum of capital, which is the *raison d'être* of banking. In other words, credit has been systematized in Scotland to the last degree, and is found to answer all purposes so long as the paper sovereign can be converted into the gold sovereign at some convenient commercial center, at the pleasure of the holder.

Money is anything that serves as a common medium of exchange and measure of value. It need not be a good measure; it is only necessary that it should be the agreed measure of any time, place, or people. We are now speaking of real money,—not of its representatives or substitutes.

Among the things used as money by various people within the historical period are cattle, cacao beans, salt, silk, furs, tobacco, dried fish, wheat, rice, olive oil, cocoanut oil, cotton cloth, cowry shells, iron, copper, platinum, nickel, silver, and gold. It would be difficult to say what had not been used as money at some time or place. Our own history furnishes an abundance of curious examples, the most instructive being the tobacco currency of the colonial period. It may be said that Virginia grew her own money for nearly two centuries, and Maryland for a century and a half. Hardly any form of currency could have been worse, the fluctuations in its value being extreme and incessant, and the social disorders produced by it enormous.

It is evident that money, when real, is a commodity, and, when representative, represents a commodity. This is true of gold as well as of beaver skins, of tobacco, of rice, or of wampum. No invention or discovery since the world began has been of so great service to mankind as that of a common measure of value. One can hardly imagine a world existing without it. To say that the most indispensable thing in the world is a thing of no value is a contradiction of terms absolutely blighting to the human intellect. As a matter of fact, however, all the things that have been used as money have possessed other value, and we have the best reason to believe that this other value led to their use as money in every instance, without a single exception.

All trade is barter, or the exchange of property and service for other property and service. The selling of wheat for gold, and then selling the gold for cloth, are really two acts of barter. The word barter is commonly used to signify the exchange of property without the use of money. It must be borne in mind, however, that *all* trade is barter, even when the precious metals are employed as intermediaries,—the latter being articles of barter also, and possessing the same value as the things for which they are exchanged. *The whole science of money hinges on this fact.*

It must not be assumed that gold is absolutely stable in value. We are concerned at present only with the comparative steadiness of value of different things,—as, for example, gold and tobacco. If gold is subject to fewer changes of purchasing power than tobacco, it is better fitted to serve the purposes of money, and will sooner or later supplant it in that function. If it is subject to fewer changes than any other known substance, it will supersede all others. The fact that it is not wholly free from variation itself will not prevent it from becoming the sole and universal money of civilized mankind.

When, in 1834-37, the United States changed its ratio to one to sixteen, gold was overvalued, just as it had been in England in 1717, and with the same consequences. Our silver began to be exported. The minor coins, being of proportional weight with the dollar, were melted and exported, and their place in the circulation was taken by light-weight foreign coins, principally Spanish and Mexican. Two halves, four quarters or ten dimes, if new and of full weight, were worth about 2 1-4 cents more than a gold dollar. Consequently they would be collected by brokers, melted, and exported. But two halves, four quarters, or ten dimes that had lost 2 1-4 cents' worth of silver by abrasion would circulate, because there would be no motive to melt or export them. There would be no profit in it.

When the great outpouring of gold from California and Australia

began in 1848 and subsequent years, the price of silver rose so that the dollar of that metal was worth in the market $1.04 in gold. This fresh advance of 1 3-4 per cent. in the price of silver carried still more of those coins out of the country,—*i. e.*, all that were worth by weight more than 100 cents per dollar in gold. So the remaining ones became lighter and smoother. Finally it became apparent that, if full-weight silver coins would not circulate on the ratio of one to sixteen, while those of light weight would circulate, it would be safe to *make* minor coins (halves, quarters, etc.) designedly of light weight on government account, of limited legal tender. There would be no profit in exporting such coins, because they would not sell as bullion for as much as it would cost to collect them.

Acting upon this principle, congress, in 1853, passed a law providing for the coinage of new half-dollars, quarters, dimes, and half-dimes about seven per cent. lighter than the old ones. These were to be coined from silver bought by the government, and not otherwise, and were to be sold to the public at par,—*i. e.*, 100 cents gold for each 100 cents of the new coins, although these were worth considerably less, at par. The new coins were legal tender for only $5.00 in one payment. There was no longer any motive to export the halves, quarters, etc., since they could not be collected for less than 100 cents per dollar and could not be sold for more. Thus we, in our turn, found out that the system suggested by Adam Smith in 1776 would work. Not only would it work, but it has proved to be the only system that would keep both metals in circulation under all circumstances. It has proved also to be the system that would call into circulation the largest possible amount of both gold and silver at any one time and place.

Such is the underlying principle of a subsidiary coinage, of whatever metal or substance it may be composed. Our silver dollar, the French 5-franc piece, and the German thaler circulate at par on the same principle. They are subsidiary coins of larger size. They are *now* worth as metal only one-half of their nominal value, but, since they are limited in number, and since the governments receive them for all public dues, they are not depreciated. Receiving them for public dues is one way of redeeming them. Our coins, smaller than $1.00, whether of silver, copper, or nickel, are redeemable by the government in gold when presented in sums of $20 or more.

If subsidiary coins circulate at a value which is largely imaginary, the question may be asked: Why not make them of some other metal, or even of paper? There are no reasons except custom and convenience. A coin not heavier than a half-dollar is more convenient than a piece of paper; it is cleaner, and in the long run is probably

cheaper, as it does not require frequent renewal. A cheaper coin might be made out of some other metal, but it is always best to conform to the habits of the people. Having been born and nurtured in a silver subsidiary coinage, no good reason is apparent why we should depart from it.

The United States adopted the double standard of gold and silver in 1792. Mr. Raguet wrote to the *National Gazette* in 1820 to explain the reason for "the disappearance of gold from the United States." Two years later he wrote again on the same subject, saying "that, although the coinage of gold continued to be large ($41,319,030 in 1820), not a gold coin was anywhere to be seen in circulation." The facilities of the mint were simply used by merchants to certify the weight and fineness of gold for exportation. There were stirrings in congress on the subject of a change of ratio as early as 1818. Various projects were brought forward. Scarcely a session passed without some movement in one house or the other. In 1834 the Gold Bill, as it was termed, was reported by a special committee of the house, of which Mr. Campbell P. White, of New York, was chairman. The debates and the newspaper discussions show that there were three considerable forces at work to promote the passage of the Gold Bill. One was the desire to have gold again in circulation. This desire found apt expression in the words of Thomas H. Benton, who declared that the object of his endeavors was:

> To enable the friends of gold to go to work at the right place to effect the recovery of that precious metal which their fathers once possessed, which the subjects of the European kings now possess, which the citizens of the young republics to the south all possess, which even the free negroes of San Domingo possess, but which the yeomanry of this America have been deprived of for more than 20 years, and will be deprived of forever unless they discover the cause of the evil and apply the remedy to its root.

The production of gold in the southern States had arisen from $5000 in 1824 to $868,000 in 1833, and the belief was generally entertained that, if the mint valuation of gold were raised, it would give the producers of that metal a pecuniary advantage. In other words, it would serve as a measure of "protection" to that industry. This was an entire mistake, but it had a considerable influence in promoting the passage of the Gold Bill.

The third impelling force was the bank controversy then raging. This was largely a party question, the supporters of President Jackson being generally supporters of the Gold Bill. The silver standard, it was contended, promoted the circulation of bank-notes because silver was bulky and heavy. The gold standard, on the other hand, would curtail bank-note circulation, because gold was easily handled. Hence the opponents of banks, were in favor of the Gold Bill.

The bill, as reported to the house by Mr. White, provided for a ratio of 1:16.60, but, when it came up for discussion, Mr. White moved an amendment making the ratio 1:16, and this amendment was adopted without a division.

It was perceived on both sides that the passage of the bill would make the United States a gold-standard country in practice. Why, then, was the double standard retained in theory? One reason was that a great many contracts were in existence, such as ground leases and bonds and mortgages, expressly calling for payment in silver. Another was that the smaller coins (halves, quarters, and dimes) were of proportional weight with the dollar. These, it was thought, could not be dispensed with, the principles of a subsidiary coinage being then imperfectly understood. So the double standard was retained in law, although discarded in practice.

In 1866, Mr. John J. Knox, who then had charge of the mint and coinage matters in the treasury department, recommended a revision of all the laws relating to the mint. Secretary Boutwell approved of the suggestion. Mr. Knox and Dr. Linderman were appointed in 1869 a committee to make such revision. They presented their report with a draft of a bill in 1870. The bill passed the senate on the 10th of January, 1871. It made the gold dollar a unit of value, and it dropped the silver dollar from the list of coins. The bill failed in the house for want of time. The forty-first congress having expired without final action, it came up again in the forty-second. It passed the house May 27, 1872, by yeas 110, nays 13. It passed the senate January 17, 1873, without a dissenting vote. The metal in the silver dollar at that time was worth 2 cents more than the gold dollar. No objection to the bill was heard until the price of silver had fallen so that the silver dollar, if there had been any, would have been worth less than the gold dollar. Then it became fashionable to say that the bill was passed surreptitiously. The truth is that the bill was before congress 2 years and 10 months, that it was printed thirteen times by order of congress, that the debates on it occupy sixty-six columns in the senate proceedings and seventy-eight columns in the house proceedings, and that the discontinuance of the silver dollar was specially discussed in the house.

Let us imagine for a moment that silver had not fallen in price after 1873. Would anybody have missed the silver dollar? Would anybody have doubted that the gold standard was brought about in this country by natural causes operating upon men's minds in the same way as it was in England?

It is said that the single gold standard has produced a disastrous fall in the prices of commodities. If it could be shown that the single

gold standard had caused the decline in prices which has taken place since 1873, I should consider that fact its best title to be considered a benefit; because it is demonstrable that wages have advanced during the same period, with the result of giving to the great mass of the people more comforts for their labor than they could command before. This is clearly shown by the report on wholesale prices, wages, and transportation made by the senate committee on finance, March 3, 1893,—a work which has never been surpassed in this or any other country in fullness, thoroughness, and impartiality.

After examining this report, Professor Taussig says:

> All in all, the figures show that the purchasing power of money wages has been rising steadily for at least 20 years, and that the decline in prices since 1873, and especially since 1882, has been a source of prosperity, and not of depression, to the community at large.

It cannot be shown, however, that such decline in prices as has taken place in recent years has been due to an appreciation of gold. Mr. David A. Wells, in his work entitled "Recent Economic Changes," accounts satisfactorily for the decline in prices of all the staple articles of commerce which have really declined since 1873, by new inventions and facilities for producing or transporting the same. Mr. Wells takes up each article separately. He shows that some articles have risen in price during the period named and some have remained nearly stationary, while among those that have declined the widest variations exist as to the percentage of decline, all the changes being traceable to known conditions of supply and demand.

We hear much about the "scramble for gold." What is meant by this phrase? Generally a thing is not scrambled for, unless it is desirable. The simple truth is that gold is the only money of civilized nations. We are all aiming as individuals to get as much money as we can. As nations are composed of individuals, it is no mystery that nations appear to be doing the same. Calling it a scramble serves only to create prejudice among the unthinking, because a scramble usually takes place in the dirt and is attended by the display of evil passions.

It is said, finally, that there is not gold enough in the world to do the business of the world. This statement would be of no consequence, even if it were true, since the real question is whether there is enough for the gold-using portion of the world, which question may be answered in the affirmative, as this portion of the world is giving ocular proof of the fact every day. As regards the future, there is every prospect that the increased supply will keep pace with any increase of demand, the production during recent years having advanced by leaps and bounds.

SIDE LIGHTS ON THE SOUTH AFRICAN GOLD BOOM.

By Albert Williams, Jr.

NOTHING has ever happened in the financial world comparable with the existing excitement about "Kaffir" stocks in the London and Paris exchanges, and in less degree throughout the other European money centers. Fortunately thus far the mania has not reached the United States, and is hardly likely to before the impending catastrophe occurs. People not on the scene, and depending for information solely upon newspaper accounts, but dimly realize the magnitude of this latest speculative upheaval. Yet beside it the South Sea bubble, the Mississippi scheme, the tulip craze, the gold speculation during the civil war, the Great Bonanza and the Leadville deals, and the Panama canal fever, pale into utter insignificance. If we consider either the volume of paper floated, the amount of actual hard cash involved, or the number of investors and speculators interested, financial history records nothing like it. Here is something in real life which, if told in a novel, would seem too utterly exaggerated and fantastic for even the novelist's license. Had Zola written "Money," or Dumas "Monte Cristo," or Chamberlain "Six Thousand Tons of gold," or Haggard "King Solomon's Mines," after instead of before the events of the past few months and what is now transpiring and still to come, they would have been warranted in materially expanding their imaginations. Think of the impulse which can lead otherwise sane persons to put more than a billion, possibly a billion and a half, of money or margins into paper of the intrinsic value of which most of them know little or nothing!

There are all shades of mining excitements, ranging from the oft-repeated "rushes" to localities of actual or supposed great discoveries, to "booms" which are purely artificial and fictitious; and between the two extremes indefinite gradations, in which mining and speculation are mixed in varying proportions. This latest instance is a marked example of the composite type, having a foundation in solid mineral wealth on which has been built, haphazard and indeed without serious premeditation, an overwhelmingly disproportionate superstructure of the wildest speculation. The old saying holds good that there are just two ways of making money out of mines: one by taking it out of the ground, in the form of dividends earned by legitimate mining; the other by making it on the street, or, in plain English, by taking it out

of other people's pockets, and considering the stock certificates merely as convenient vehicles for gambling. By each of these methods colossal fortunes have been obtained. Of the two the latter is no doubt the easier and the more expeditious; but it has this disadvantage, from the ethical point of view, that there is no accretion to the general wealth, but only a transfer of money from one to another, with a final concentration in a few hands, which cannot but be deplorable as a matter of financial economy. It must be remembered that to produce a single multi-millionaire in this manner implies the combined losses of a myriad of small and unlucky speculators.

That the South African gold mines presented an inviting field for legitimate investment and development is unquestioned. Many of them are very valuable properties, and have yielded handsome profits to their owners; while the known gold-bearing area is very large and may be depended upon for a long-continued output, which for an uncertain length of time will undoubtedly show a steady increase with the extending of the workings and augmented milling capacity. So much money as is now being put into actual development of the mines and construction of new reduction plants cannot but result in larger returns. Up to a certain point, therefore, the recent and present speculative excitement has been beneficial to the real work of mining; it has acted as a stimulus to bring in capital which might not have been secured on the merits of the mines as reasonable investments. But the whole thing has been overdone. There have been no startling discoveries of late. There has been no rush of prospectors, although an immense number of claims have been sold; there have been no new finds of importance. The mines are there, just as they were a year ago: some of them turning out their regular quotas of gold; others engaged in dead work to reach pay ground previously tested with the diamond drill, or presumed, on geological evidence, to exist; and others still being prospected on chance, as always happens in new mining districts. The mines have not changed, save in the direction of a natural and healthy growth; the difference has been in London and Paris. Once these same mines were underrated; then their steadily-increasing yield began to attract attention, and they became justly appreciated; next the public, which would not touch them only a little while before, was seized with a mad infatuation and stampeded for shares, and the market ran away with itself, surprising the earlier promoters, who engineered the first deals, and leaving many of them behind. And lastly ——?

In a preface to a book just issued, entitled "The Gold Mines of the Rand," by Messrs. Hatch and Chalmers, Mr. John Hays Hammond, a California mining engineer who has recently examined the

Transvaal mines, makes this strong statement: "It is obviously impossible to make an approximate estimate, but I would regard as well within the bounds of conservatism the prediction that the annual output before the end of the present century will exceeed $100,000,000 worth of gold." If Mr. Hammond's estimate proves to be correct,—and it is less sanguine than some which have been put forth,—this would mean an increase of nearly 80 per cent. over the world's annual gold output of a few years since.

The gold production of the Rand since the first regular mining in 1887 has been as follows, expressed in troy ounces at the bullion value of about $18.50 per ounce:

1887	23,155	1891	729,247
1888	208,121	1892	1,210,867
1889	369,557	1893	1,478,473
1890	494,817	1894	2,024,159

For the first 9 months of 1895 the output was 1,711,837 ounces. The annual yield is, therefore, now at the rate of about $41,000,000. The figures for all of the South African gold fields vary somewhat, but the outlying districts produce something over $5,000,000 annually, in addition to the Rand production. For 1894, the last full year, one statement places the total yield at $37,988,076 (selling value), of which $30,412,782 came from the Rand. A writer in the New York *Mail and Express* states the number of stamps in operation in 1894 at 2300, and this year there are 2600, upon which crushing capacity is based an estimate of over $50,000,000 for 1896, at which rate the South African gold mines will lead those of the United States in 1896 or 1897.

So far, it will be observed, the production, while large, is by no means without precedent. It is in the assumed reserves of ore, and the vague estimates of future returns, that the peculiar attraction of the South African mines is to be found. California, which altogether has produced nearly $2,000,000,000 worth of gold, in the palmy years of the early fifties yielded $55,000,000 to $60,000,000 annually, and Australia has nearly as good a record. But in California and Australia there was for a long time practically no speculation; in both cases the excitement ran in the direction of the actual getting of gold, not of floating shares, and both countries swarmed with eager gold-seekers equipped with pick, shovel, pan, and rocker, ready to face any hardship and privation to win the coveted metal, but wholly innocent of the advanced arts of the modern promoter. In California the yield for some time averaged about $6000 a year for each man, woman, and child, including Indians, in the State,—much more, of course, for each working miner,—and in the irregular distribution the more lucky ones far ex-

ceeded the average. But the California mines were shortly brought into the humdrum stage of quiet, systematic mining, with little speculation (though San Francisco has witnessed exciting times over the stocks of Nevada and Idaho mines); and latterly, owing to the suppression of most of the hydraulic mining, the annual yield is only about a fifth of what it was at its best.

The Nevada mines (popularly classed as silver mines, although most of them gave large percentages of gold) affected the stock markets much in the same way as the South African mines have done, though always on a smaller scale. That is, there was first the rush of prospectors; the opening of mines; in some cases very heavy outputs; then the floating of a vast amount of stock,—some of it valuable, some utterly "wildcat" in character. The Comstock lode was used as an excuse for stock gambling, but it also had substantial merit. In all, it has produced about $360,000,000, of which about one-third was gold. In the many booms some surprising advances in stock quotations were made. When the shares were divided according to the linear feet in the claims (one share for each foot), several of the stocks rose from next to nothing to $6000 and $8000 per share. Later, when the stocks were largely watered, Crown Point and Belcher soared in a few weeks from obscurity to nearly $2000 a share. In the "big bonanza" excitement, Consolidated Virginia and California (then two separate mines), with a capitalization of $12,000,000 each, in 112,000 shares of a nominal par of $100, rose in a few months from $75 to $780 and $810 respectively, although a few years previously these same stocks had been hardly able to carry their assessments. But these Comstock deals, the cause of excitement never known in any mining speculation before, are simply eclipsed by the South African boom. At the most, the total value of all the Comstock paper at the quotations for any one day probably did not exceed $300,000,000, or at most $400,000,000. The lode is only about 4 miles long. There were about twenty or thirty claims which could be termed *mines*, and several hundred others of the species wildcat. The bulk of the production came from only four mines; all the others, no matter how prosperous for a time, in the end showed losses, the assessments far exceeding dividends, while some of the mines which never paid a single dividend were operated at a cost of several millions each. White Pine, Eureka, Reese River, Tuscarora, and other Nevada camps, and the Owyhee district of Idaho, also came in for speculative attention in their turn.

Leadville, Colorado, the next greatest American mining district after the Comstock, has produced something over $200,000,000 in silver, gold, and lead. The shares of its mines have had their ups and downs in the New York and London markets, though the general

public never went crazy over them. It is worthy of note, as a warning for the immediate future, that, after the collapse of Little Pittsburg and Chrysolite, English capital for several years was very shy of American mines, or mining of any kind. The same effect followed the previous break in Little Emma and other Utah mines owned in England.

At present the gold district which is receiving the most attention of any in the United States is Cripple Creek, Colorado, where there are several very prosperous mines and an unlimited number of prospects. This district, yielding at the rate of about an eighth of the Transvaal mines, has attracted considerable foreign capital, but this has been the money of capitalists, not of small speculators, and most of the mines are owned at home.

Simultaneously with the South African deal, a lesser boom has been exploited on the London market. This is the West Australian boom, founded upon discoveries of very high-grade gold-ore in that colony. It is not at all a small boom, appraised on ordinary terms, but is left in the shade by its giant rival. The West Australian mines are at great disadvantage as to water, timber, supplies, and transportation. In spots the country is evidently very rich, but, in accordance with the invariable custom, a huge number of prospects and probably worthless concerns have been carried along by the returns from the relatively few good mines. The rush to West Australia seems to have subsided, but the mines are being worked—mostly in London!

A mining engineer, now in New York, told me a remarkable story the other day about the floating of one of the South African stocks. The prospectus, he said, was the most cynically honest one that he had ever seen. In brief, and stripped of all technicalities and verbiage, it amounted to something like this, paraphrased: "We have a piece of ground in the Transvaal, on which we are about to issue shares at public subscription. No gold has yet been found on it, but it is in the neighborhood of some very profitable gold mines, and we offer the stock on the chance that we *may* find some gold in our ground too." On the strength of this, my informant's story goes on to say, there was an over-subscription of stock, and it went at much above the nominal par the first day it was on the London exchange, at which price the total valuation for this undeveloped and untried tract of South African land represented a very large sum.

Similar stories are numerous. Very many of the stocks have been floated at much more than the nominal capitalization, the public subscribing several times over for the shares before the allotment. When the opening quotations for a new stock are much beyond the figure to insiders and their friends, it is natural to expect that in the allotment

the public does not get the shares at the original subscription price, but that the shares are all taken in by the promoters at that figure and turned out on the market at the advanced quotation. This has been done over and over again in London. It is one of the perquisites of the promoters, but never before was it such a "sure thing."

Besides the stocks of mining companies, the South African boom has created a host of enterprises, such as investment companies, exploration and development companies, banks and trust companies, parent promoting companies, and subsidiary offshoots, all of them offering shares for sale, and some of them representing no actual property whatever, but merely a chance of getting hold of something to "handle." One of the most extraordinary events has been the marketing of shares in the new Barnato bank. Its nominal capital is $12,500,000. The $5 shares opened at $23, and the total valuation of its stock exceeded $40,000,000 before it had begun business. As a matter of curiosity I give here the nominal capitalization and the market price in the middle of October of twelve representative South African concerns. It should not be forgotten that at the time the promoters decided upon the amount of nominal capitalization they were nowise diffident, the main check being the fees for incorporation. The table was compiled by the London correspondent of the New York *Sun*.

	Nominal capital.	Market value.
Barnato Bank	$12,500,000	$45,310,000
Barnato Consols	6,250,000	35,155,000
British South Africa	12,500,000	107,810,000
Consolidated Gold Fields	3,125,000	59,375,000
De Beers Diamond	19,750,000	127,385,000
East Rand	3,250,000	40,625,000
Johannesburg Con. Inv.	4,000,000	25,000,000
New Jagersfontein	5,000,000	11,750,000
Modderfontein	875,000	13,350,000
Rand Mines	1,663,500	79,857,500
Randfontein	10,000,000	41,000,000
Robinson Bank	15,000,000	37,500,000
Totals	$93,915,500	$624,367,500

Comment is hardly necessary. The figures speak for themselves. These twelve stocks are extreme examples. They are not wildcats; they are the gilt-edged stocks; but how much they have been overrated is a conundrum.

The most striking figure in the financial world is "Barney" Barnato, a few years ago a penniless adventurer, and only a few months past entirely unknown to fame. Now he is worth—— well, some reports say that he would be the richest man alive if he could only "cash in" his paper holdings. To attempt to do so would be to break the market at once, which he is too shrewd to do. But he has plenty of

substantial investments to fall back upon, if he does not come to grief in the London exchange. All this money, real money and paper alike, came, not from the mines, but from fortunate speculation, in which he backed his luck with a courage or a fatalism never perhaps equalled.

It cannot be said that the financial and daily press, as a whole, has done much to further the boom. On the contrary, the journals of best standing have all along sounded the note of warning. The London *Economist* many weeks ago, by way of exhibiting the extremely speculative character of the movement, took the most favorable estimate of the future output, and, by comparing it with the total market quotations on the present capitalization, easily proved that these quotations were absurdly high. Commenting on this, the New York *Evening Post* pointed out that this, at best, is unsatisfactory as a test of individual properties; such averages merely prove that some companies or "banks" are based on unreal expectations, but leave the problem of individual values untouched. "The same process applied to all the English railway common shares, or to American shares either, would show equally poor prospects, because those stocks paying little or nothing (amounting in the United States to nearly two-thirds of the total) would pull down the average of the whole; but should we sell London and Northwestern or New York Central on such a table?" Conceding this objection to the principle of general averages, what the *Economist* did show was that, when quotations were only about $750,000,000 for all the Kaffir stocks, the dividends stood for an insignificant percentage, far below current rates of interest. Hence, if some of the mines were good investments, the ruck must be very bad indeed. Besides this, there is the original investment to be made good, in view of the ultimate exhaustion of the mines, either by a sinking fund or an equivalent increase in dividends. The *Statist* has plainly warned the English bankers of the danger of complications arising from their foreign correspondents, especially the French banks; and it was the caution of the London banks in calling in foreign loans that caused the flurry in October.

What will be the outcome? It is unsafe to predict with any definiteness as to details. Everyone, even the most unscrupulous promoters and the most sanguine dupes, knows that sooner or later there must be an end, that sooner or later must come the inevitable day of reckoning, just as always has happened. But precisely at what point the climax will be reached, and whether it will culminate in one sudden and universal smash, or whether there will be any premonitory indications, gradual breaks and recoveries, but on the whole a downward tendency, until the stage is reached at which the great body of margins are uncovered, and then a final slaughter of all South Afri-

can stocks, good and bad alike,—as to this no one can tell. Many onlookers thought the top had been touched long ago, and many who went in "on the ground floor," or at what now seem to have been comparatively moderate figures, drew out months back, believing that they had carried their holdings as far as was prudent.

Once in October last it looked as though the market were going to pieces. An incipient panic set in, there was a sudden rush to realize, prices fell off disastrously; but Barnato and some of the other insiders stepped into the breach, and, by heavy purchases, stopped the decline and restored confidence. Barnato is reported to have offered to advance $100,000,000, if necessary, through his bank, on South African stocks. But the time is coming when not all the capital and credit of any one man or clique will avail to avert disaster. The magnitude of the deal is too great for that.

Three things may be set down as certain:

1. When the catastrophe falls, it will be one of the worst, if not the very worst, disasters that have ever shaken the European financial world. It may come at any moment, perhaps even before these lines are printed, or it may be indefinitely put off. No one knows. But, when it does come, it will mean ruin to thousands of small investors and the annihilation of some large paper fortunes.

2. After it is all over, there will be the usual reaction toward ultra-conservatism. Speculation, especially in mines and distant ventures of all kinds, will be at a low ebb for years in Europe,—that is, until the events of the present are partially obscured by time, and a new crop of speculators springs up.

3. The ultimate effect will be injurious to legitimate mining. Not South Africa alone, but all mining regions, will suffer. Mining requires capital, often in heavy amounts, before successful results are attainable. The money is needed for development, for mining machinery, and for reduction plants; and sometimes the whole question of profit hinges upon the ability to work on a very large scale,—that is, with a large preliminary investment. Capital is scarce or does not exist in the mining districts. It has to be sought in the great money centers. When a feeling of distrust pervades the money markets, mining investments are peculiarly sensitive and at the greatest disadvantage. Consequently it may be expected that it will be extremely hard to interest capitalists, and still more so the public, in any mining enterprise, no matter how meritorious, until the South African experience has been forgotten. Such has always been the case hitherto, and will be in this instance. In the course of time there will be a natural readjustment of ideas, but meanwhile the outlook for mining investments will be very unsatisfactory.

THE DISTRIBUTION OF ELECTRIC POWER AT NIAGARA.

By the late Franklin Leonard Pope.

ON the morning of August 26 of the present year the Niagara Falls Power Company commenced the transmission, for commercial purposes, of the electric power generated by the great hydraulic and electric plant which has been under construction for the past 5 years, and which, not alone by reason of its magnitude, but also on account of the boldness, originality, and succcess with which the many novel problems in civil, mechanical, and electrical engineering to which it has given rise have been attacked and solved, has attracted the attention and excited the admiration of the civilized world. From a technical point of view there seems to be no question that the expectations of those interested in the promotion and accomplishment of this gigantic undertaking have been fully realized. The results which have already been attained, culminating in the successful transmission of electric energy to the amount of some thousands of horse power to the works of the Pittsburg Reduction Company for use in the manufacture of aluminium, render it certain that the vicinity of Niagara Falls will in time become one of the greatest manufacturing districts of the United States, if not absolutely the greatest.

But one portion of the problem proposed to themselves by the projectors of the Niagara enterprise still awaits its solution,—the question of the transmission of power to a distance in competition with steam power of local production. Much has been said and written in reference to this question, and it is but just to say that at the present moment there exist the widest differences of opinion on the subject among presumably competent authorities. Some eminent experts do not hesitate to express their belief that power can be delivered at any point within a radius of 200 miles cheaper than it can be locally produced by steam engines of the most economical type using coal at $3 per ton, while others of equal eminence, and perhaps greater practical experience, maintain that it cannot be delivered at a profit, even at such a comparatively short distance as that which separates Buffalo from Niagara,—less than 20 miles as the crow flies. In view of the interest and attention which has been excited in every part of the world by the progress and partial completion of the works at Niagara, this has seemed to the writer an opportune time to present to the readers of the ENGINEERING MAGAZINE a summary of some of the

most important contributions recently made to the discussion of the commercial aspects of the problem of electrical transmission of power, with especial reference to the case of the Niagara plant.

Professor George Forbes of London, the electrical engineer of the Cataract Construction Company, in a recent, and in some respects very remarkable, article in *Blackwood's Magazine*, has given a history of the work from his own point of view, from which many facts of interest and importance may be learned. It appears that, when the Niagara Falls Power Company was formed in the autumn of 1889, nothing had been decided upon as to the plan of the work, beyond the general conception of the vertical shafts and horizontal tail-race excavated at the lower level for carrying away the water from the turbines. The entire question of distribution for both short and long distances remained in abeyance. In 1892 it was determined that the distribution should be effected by alternating currents of electricity, and from that time forward the work was carried on in accordance with that decision. The capacity of the present tunnel is equivalent to 100,000 h. p. The turbines and electric generators are in units of 5000 h. p. each, of which three, or 15,000 h. p., are now in place. According to Professor Forbes, about $5,000,000 has been expended on the work so far as completed, so that perhaps we shall not be far out of the way if we assume that, by the time the 100,000 h. p. has been installed, the cost of construction will have been about $70 per h. p.

Professor Forbes says: "The directors have no present desire to send the current to great distances. It will pay better to create a smokeless manufacturing town in the neighborhood. If required, the power could be sent much more than 100 miles, and still be more economical than steam, even though coal is cheap there." And again: "One of the ablest of American engineers said in public 3 years ago that it was impossible to transmit the power of the Falls to Buffalo, some twenty miles, so as to make it pay; whereas we have now established the fact that the limit of distance is to be counted by hundreds of miles." Messrs. Edwin J. Houston and A. E. Kennelly, two well-known electrical engineers, published last year an interesting paper, entitled "An Estimate of the Distance to which Niagara Water-power can be Economically Transmitted by Electricity." After an elaborate computation based upon certain assumed data, the authors sum up as follows: "The broad conclusion to which an inquiry of this nature inevitably leads is that, while under ordinary conditions the commercial limit of electrical transmission of power from water powers of less than 500 kilowatts can hardly exceed 50 miles, the radius at which it will be profitable, with good fortune and manage-

ment, to electrically transmit a water power aggregating 50,000 kilowatts or more is perhaps to-day 200 miles, and that it might be commercially advantageous for such a large water power to undersell large steam powers at twice this distance with no profit, in order to reduce the general expense upon delivery nearer home." Mr. S. Dana Greene, the assistant manager of the General Electric Company, who has had much practical experience in the installation of electric power-transmission plants, has recently expressed his belief in the substantial correctness of the views of the authorities last quoted.

It appears, nevertheless, somewhat significant that, so far as can be learned, no work has actually been commenced upon the transmission line to Buffalo. In explanation of this circumstance, Professor Forbes, in speaking of the work carried on by him as consulting electrical engineer of the construction company, said: "I decided on all this transmission plant, and it is not now put in only because the Buffalo people want to get the power for next to nothing. There is too much 'politics' in this business at Buffalo." On the other hand, there are very eminent engineering authorities who do not hesitate, even now, and in the face of all that has been accomplished, to express the opinion that the real reason is that, if the electric power is furnished to the manufacturers and electric plants of Buffalo at a price sufficiently low to justify them in abandoning the steam plants now in use, the amount of profit remaining for the Niagara Power Company will be too small to justify them in undertaking to supply it from their plant at the Falls. A very instructive discussion of the comparative cost of power from different sources took place at the meeting, last June, of the American Institute of Electrical Engineers, upon which occasion Mr. Charles E. Emery, a very distinguished steam engineer, pointed out that the true basis of comparison is the relative cost of power delivered in desired quantities to the several consumers as compared with the cost of steam power on the premises. He agreed with Mr. B. J. Arnold, who had previously stated that in the best modern steam plants of say 100 h. p. the cost of power, delivered upon the engine shaft, is about 1 cent per h. p. hour,—a figure which includes interest, depreciation, attendance, and all other expenses, as well as fuel. He further agreed with Mr. Arnold's computation that, in order to compete with steam for power, electricity must be transmitted from the dynamo at Niagara to the manufacturing establishment in Buffalo, and delivered at the switchboard to the small motors used to drive the machinery of the factory, at a net price of 1.5 cents per kilowatt hour, equivalent to 1.125 cents per h.p. hour. Now, it appears that, in the contracts which the Niagara Power Company make with the consumers, the latter are required to pay for a certain maximum quantity of power, which they

are not permitted to exceed, even temporarily. The schedule of prices, as ascertained from the officials of the Power Company, at the request of Dr. Emery, has been fixed at $10 per h. p. per year for undeveloped power, $13 for power delivered at the top of the turbine shaft, and $18 for electric power delivered at the terminals of the dynamo,—this being for 24-hour power, or 8766 hours per year. It was stated by Mr. Peter Wright that these prices were for a minimum of 10,000 h. p., but that the Carborundum company, a large consumer located a short distance away from the power-house, was to pay $20 per annum under their contract for 1000 h. p. This amount of power must be paid for by the consumer, whether used or not. In manufacturing industries generally the power is employed only 10 hours per day, or, say roughly, 3000 hours per year. Dr. Emery pointed out that, figured on this basis, $18 per h. p. per annum at the terminals of the Niagara dynamo would be equivalent to 0.6 cents per h.-p. hour, leaving but 0.4 cents per h.-p. hour to pay the cost of interest, depreciation, administration, etc., of the step-up and step-down transformers, the transmission line, and the organization for local distribution in Buffalo, if the power is to be delivered at a price which will commercially compete with steam.

An anonymous writer in a technical journal has recently analyzed the problem with very much the same result. He says:

> The proposition of the Niagara Power Company is to sell a h. p. at the Falls for $10. If the city of Buffalo, or any one else, accepts this proposition, they must pay $10 for the h. p., whether they use it or not. They have the privilege of using it for 8760 hours in the year. What can it afford to sell this power for at Buffalo? Let us take the maximum efficiencies that actual practice, under favorable conditions, will give, and see how much of this h. p. we have to sell after transmission and distribution. We think no one will claim a *better* chain of efficiencies in actual practice than the following:
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> Efficiency of turbines, 80 per cent.; turbine shaft, 95 per cent.; electrical efficiency of dynamo, 90 per cent.; combined efficiency of step-up and step-down transformers and electrical transmission to Buffalo, 75 per cent.; efficiency of transformation from alternating current to direct current, 90 per cent. This will leave but 46.17 per cent. of the power we have bought to sell, and it has cost us $10, or at the rate of $21.66 per h. p., if used continuously. In electric-lighting stations the average consumption is rarely as high as 40 per cent. of the maximum; but let us assume that in Buffalo the average demand will equal 60 per cent. of the maximum. The maximum which we have to deliver is but 0.4617 h. p., but the average demand upon which we could rely would be but 0.277. This has cost us $10 at Niagara. Its cost at Buffalo is, therefore, at the rate of $36.10. If we allow an efficiency of 90 per cent. for distribution, it will cost $40.11 per h. p. But we have charged nothing for interest and depreciation on wheel pits, side canals, wheels, transformers, dynamos, or line; nothing for labor, attendance, and administration; nothing for expert advice, cost of experimenting, or interest on investments during period of installation; nothing for right of way, insurance on buildings, and nothing for interest on the investment for apparatus, etc., which the customer must make before the power delivered at his door

can become available, and which will be a factor with him in deciding whether he will become a customer or not.

Without attempting to enter into an elaborate computation of these additional items of cost, even if it were possible to estimate them with even approximate accuracy, we may say that the sum total will certainly exceed considerably the cost of locally-generated steam-power in Buffalo. While it is not at all unlikely that the average cost of steam power in Buffalo to-day may be 50 per cent. higher than the figure given by Messrs. Arnold and Emery, which may be taken at $31 per year, yet it must not be lost sight of that the electric power must compete, not alone with actually existing conditions, but with the best conditions ordinarily attainable in every-day practice.

Mr. H. Ward Leonard, a well-known electrical engineer, in a communication to a technical journal some time since, said: "It does not seem reasonable to me that a manufacturer having a steam plant already in operation will consider taking electric power, unless there is a saving of nearly 50 per cent. in the cost of power, for he must still retain his boilers for heating, and, as his engineer usually acts as machinist for all his machinery, he cannot save his salary by using electric power. In most industries the cost of power is not more than 10 per cent. of the cost of manufacture, and, if there be any considerable increase in the liability of failure of power, it will require a very great inducement in order to make the change to electric motors attractive. Furthermore, most manufacturers believe that they are producing power at about one-half to two-thirds the figures given by Emery's tables, and, although they are probably in error, it is their low estimate of their cost of production which must be materially reduced before the proposition to use electric power becomes attractive to them."

One of the most interesting of the many contributions to this discussion is that contained in a pamphlet issued by the veteran engineer, General Herman Haupt, late chief engineer of the Northern Pacific Railroad, who will be remembered as a pioneer in the construction of the Hoosac tunnel and of the Tidewater pipe line, the first successful attempt to pump oil from western Pennsylvania to eastern shipping points, and whose opinion in a matter of this kind is entitled to much consideration. While some of his assumptions respecting the transmission of electric currents at high voltages are not free from error, these are not of sufficient importance to vitiate his argument as to the commercial practicability of supplanting steam-power at Buffalo by electric power derived from Niagara Falls. General Haupt, however, goes much further than this; he boldly takes the ground that the attempted employment of electricity for the distribution of power from

Niagara is an engineering mistake, and contends that the only economical and commercially feasible plan is that which depends upon the use of compressed air. The proposition to employ compressed air for this purpose is by no means a novel one. As long ago as 1860 the late Horace H. Day, who constructed the hydraulic canal at Niagara which has supplied power for a number of manufactories since that time, proposed to distribute the power in this manner, and he expended a large amount of time and money in experimenting near Bloomingdale, N. J., with compressed air machinery designed to carry out his purpose. It appears that, even so late as 1890, Mr. Francis Lynde Stetson of the Niagara company was advised by Mr. George Westinghouse that power could be transmitted from Niagara to Buffalo, not by electricity, but by compressed air. Mr. Stetson tells us that the matter received the most careful consideration at the hands of the international commission of engineers, and that the three leading pneumatic installations of the world were visited and examined,—*viz.*, the Popp system in Paris, in which 7000 h. p. is distributed by compressed air throughout that city, operating more than 30,000 clocks in the hotels and residences, and supplying refrigeration for the cold-storage warehouses, and an electric-lighting installation near the Madeleine; the Sturgeon & Lupton system in Birmingham, England; and that of the Chapin iron mine, at Iron mountain, Mich., in which the power is transmitted a distance of 7 miles. The efficiency of the Popp system is stated to be only 38 per cent. and that of the Birmingham system 52 per cent., both for comparatively short distances, and for this reason, Mr. Stetson says, "it did not seem wise to the Niagara Falls Power Company to adopt this system, useful and valuable as it is in many particulars."

The observations of General Haupt in this connection are of interest. He says in his pamphlet:

> An eminent financier recently remarked to the writer that he had no faith in the use of compressed air as a means of transmitting power: that it had been fully tested in Paris, and had proved a failure, and that great losses had been sustained by the investors.
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> The reply was that no one had a right to expect success where the essential conditions have been violated. All attempts heretofore at power transmission, so far as known, have been at low pressures of from 100 to 200 lbs. per sq. in., but the loss of power in transmission, with a given weight of air, under 200 lbs. initial pressure, is ten times as great as if the pressure were 2000 lbs. To use steam power to compress air, transmit this air through pipes at a low pressure to a distance, and use the air cold to drive dynamos to generate electricity in competition with power generated locally by the use of coal, would be the height of folly, and no better results would follow from the similar use of electricity as the medium of transmission; but, if air can be compressed by the power of a waterfall, for which there is no other use, and transmitted at an initial pressure of 2000 lbs., and reheated before use to double its efficiency, then the

essential conditions of success will have been complied with. These conditions do not appear to have been recognized; failure was a necessary consequence, and the discredit of failure should not attach to the principle of air transmission, but to the defective manner of its application.

It has been assumed that only one-half of the power expended in compressing air could be recovered in the subsequent expansion of the air in doing work, and that much loss was sustained by friction in pipes, where transmitted to long distances.

On the contrary, it can be conclusively demonstrated that the power actually utilized in foot-pounds in the cylinder of a motor is largely in excess of the power expended in compression, and that air, under high tension, can be transmitted to very long distances with no diminution whatever in the amount of work that it is actually capable of performing.

He then enters into a computation based on the results of the experiments of the scientific commission at the Mont Cenis tunnel, showing that 2500 effective h. p. can be transmitted through a 6-inch pipe for a distance of 100 miles with an initial pressure of 2000 lbs., and a terminal working pressure of 147 lbs., with no loss of efficiency in the transmission, since pressures in excess of 150 lbs. cannot be utilized, and the friction of the pipe is merely a substitute for the reducing valve.

A comparison is then made of the cost of power thus transmitted with the cost of locally-generated steam power.

The cost of a line of 100 miles of 6-inch pipe will be $400,000, the interest on which, at 5 per cent., is $20,000.

To furnish 2500 h. p. of air will require 12,120 cu. ft. of free air to be compressed per minute, and the cost of compressor plant will be $110,000, the interest on which would be $5500. To this must be added for repairs and labor $7500, making a total of $37,000, or $13.20 per h. p.

The price proposed to be charged for power at Niagara at the shaft of the turbine is $13 per h. p., and, if the same allowance be made for water power in other localities, if used to compress air, the cost of power delivered at the end of the 100-mile pipe will be $26.20 per h. p. per annum.

At the Buffalo city water works, with engine capacity of 3600 h. p., the average cost of steam power is given at $77.55, and at Milwaukee water works at $75.83, but this includes, not only the boilers which generate the steam, but also the engines by which it is applied.

The cost of boilers alone, at $25 per h. p., would be $62,500; the interest, $3125; depreciation and repairs, $6250. If, as an average for most localities, 3 lbs. of coal be allowed per h. p. per hour, at $4 per ton, and 300 days of 12 hours to the year, the annual consumption of coal would be 13,500 tons, at a cost of $54,000.

To this must be added wages of firemen to handle 45 tons of coal per day,—say six firemen at $1.50 per day, making the cost of steam-power delivered from boilers—

Interest on cost of boiler plant	$ 3,125
Depreciation and repairs	6,250
13,500 tons of coal @ $4	54,000
Wages	2,700
2,500 h. p. @ $26.40 per h. p.	$66,075

This computation will show a slight difference at a central distributing station in

favor of compressed air transmitted 100 miles, assuming the cost of water power to be equal to the proposed charges at Niagara. If the cost of distribution be taken into consideration, the difference would be in favor of steam, and 100 miles would therefore appear to be the limit of economical transmission of power generated from waterfalls at Niagara prices and transmitted by compressed air; but there are some other considerations of a very interesting character that will be presented.

Mountains of refuse coal lie at the mines, which, with properly-constructed boilers, might be burned, and become a source of power in the generation of steam. The cost of such steam, produced at the mines, would be the interest and repairs of plant and wages of firemen, the coal costing nothing. These items amount to $5 per h. p., as against the $13 proposed to be charged at Niagara for water power at the turbine shaft.

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[The foregoing article was left unfinished at the time of its author's sudden death. It has since been completed, however, by his brother, Mr. Ralph Wainwright Pope, and this completion is given below.—THE EDITOR.]

The sad circumstances under which the writer has been called upon to complete the above article, to which his late brother had given such earnest thought, constitute his only excuse for undertaking a duty which no hand or brain but that of the author could properly perform. The Niagara Falls plant embodies a combination of those branches of engineering with which the late Mr. Pope was most familiar by natural taste, professional practice, and lifelong study. There is probably not another undertaking under discussion to-day to which he would more naturally turn his attention. The boldness of the conception; the massive construction; the conscientious effort to attain the best results in every particular,—were all of a character to appeal to his broad and cultivated mind; therefore, as one confronts the vacant page upon which were to appear the conclusions he had arrived at, there arises a feeling of incompetence to grapple with the subject as he, with his thorough mental equipment and judicial training, would have done. The question of undeveloped water power was a most familiar one to him, and, possibly for this reason, he recognized at an early day the important field awaiting the future application of electrical transmission of power. Since boyhood he had been familiar with the water powers of the Housatonic river. Like many others, he had possibly wondered why Falls Village, Connecticut, had not become a second Lowell, Lawrence, or Manchester. There was Canaan Falls, with its completed canals waiting year after year for the wheels, the mills, and the spindles which never came. There was also that locally-famous power in the town of Stockbridge, occupied perhaps 40 years ago by Algier's furnace. Buildings as well as dam had crumbled into ruins within his recollection. Something was evi-

dently lacking; else this mighty force of falling water, existing in hundreds of other locations, would be brought to the assistance of man in his continual search for cheap sources of power.

As a triumph of engineering skill, the Niagara Falls tunnel, with its hydraulic and electric plant, is a work which no man could more heartily appreciate than the late Franklin Leonard Pope. Here, he might well say, is an investment of $5,000,000, a practically everlasting monument to international engineering skill. Upon this plateau, extending for miles to the eastward of the power-house, may be built the ideal city of the world. From its developed 100,000 h. p. may be derived whatever energy is necessary to turn every wheel, to light and heat all private and public buildings, and to weld, forge, or smelt whatever metals may be brought to the locality. Here may yet be seen a city without smoke; a city with an inexhaustible supply of pure and wholesome water; a city with a perfect system of drainage; a city bearing the name already known wherever the pen and the printing press have told, and the mails have distributed, the story of Niagara. Throughout the 5 long years occupied in its construction there has existed a definite idea as to the future of the undertaking. The mere fact that the problem of transmitting power to Buffalo, or to Albany, or even New York city, has been discussed does not prove that such a scheme is contemplated. In fact, it has been an ideal question for debate, owing to the elasticity of the various opinions which have been passed upon it. Is there any reason why the Cataract Company should be desirous of finding a market for its energy in Buffalo? It does not appear to the writer that the occasion has yet arisen. The true field for power distribution lies within a radius of 10 miles of the power-house. Are the inducements offered sufficient to attract to Niagara the necessary aggregation of industries to practically utilize the power soon to be available? It is just at this point, that a question of doubt arises in the minds of those who have studied this interesting question in all its bearings. What was originally an engineering and financial problem becomes now more complex, embracing, as it does, various commercial, economic, and even social phases. The cost of power in itself is subordinated by other factors in certain lines of manufacturing. Established industries, especially those which are now being conducted with profit, are not disposed to make a radical change in location, unless sufficient advantages are offered to outweigh whatever expense and inconvenience might arise therefrom.

Again, there are comparatively few industries in which the item of power is a large percentage of the total cost. Among these are notably the very establishments which have already contracted for power, and are now in operation, deriving their energy from the Cataract

plant. One of these, a paper mill, absorbs about 3000 h. p., using its own turbine, and is said to be the largest establishment of its kind in the country. The manufacture of paper requires not only a large amount of power, but also an ample supply of pure water. Wood pulp now enters so largely into the composition of paper that proximity to vast forests is also a factor of great importance. Should experience prove that paper can be manufactured at Niagara Falls more cheaply than elsewhere, new mills may be established, while those now in existence elsewhere will continue in competition under the changed conditions probably for years to come. When the Holyoke water power was developed about 40 years ago, Lee, Massachusetts, was the most important paper-making centre. Gradually, however, Holyoke forged to the front under more advantageous conditions, one of which was cheaper and better transportation facilities. Lee has failed to maintain its supremacy, although paper-making is still its leading industry. The production of aluminium and carborundum at Niagara are new industries, although both are instances of removal from a distant city (Pittsburg), which has long been considered a most desirable manufacturing location. The existence of cheap fuel at that point, in spite of which these concerns have made this significant change of base, would seem to indicate that Niagara will afford great advantages to large power consumers. It is quite possible that in each of these cases special inducements may have been offered in order to stimulate the demand for power.

A recent editorial in *Electric Power* calls attention to a possible development of large power consumption in a comparatively new field in the following words: "We believe that electro-chemical processes will increase to such an extent that a very large part of the power now developed can be disposed of to them, and that chemicals now imported at high prices from foreign countries, where power is small but labor cheap, will be made here at much lower prices by means of the cheap power at Niagara Falls." If the interests of the affiliated Niagara companies were confined to the simple production of power, the best possible market for its sale would be sought, whether far or near. As large landholders in the vicinity, however, the prospective increment in real estate values assumes importance to them. It is well understood that the surrounding territory is a region of cheap coal; therefore the economic problem of electrical transmission is quite different from the conditions existing where installations covering distances of from 15 to 20 miles are in commercially successful operation. In ordinary practice, however, Mr. H. A. Foster* has

* *Electrical Engineer*, June 26, 1895

found that, in eleven different establishments in Buffalo, the cost of steam per h. p. per annum ranges from $32.70 to $233.95. The total power included in this report is 6300, or about one-tenth the estimated total power used in that city, according to Lieut. S. Dana Greene. It is evident, therefore, that the high efficiency claimed for the best steam plants is seldom attained in ordinary practice. If the existing plants in Buffalo were so grouped that they could readily be served from centrally-located power stations operated at the highest efficiency, no doubt a considerable saving could be effected. The question of location and convenience, however, necessitates the present arrangement; therefore the flexibility of electrical distribution might lead to the substitution of the motor for the steam engine in many cases where the question of heating and the use of steam in manufacturing was of little importance.

It is not always safe to base important plans upon possible economies, unless a clear case can be proved. Assuming that power may be distributed in Buffalo electrically at $40 per h. p. per annum, ten of the establishments noted by Mr. Foster might save the following sums yearly: $5500, $2400, $8800, $7760, $4200, $5460, $3330, $2200, $2040, and $2660. In one case only, where the cost per h. p. is given at $32.70, would the result be in favor of the existing plant, to the amount of $10,220.* When confronted with figures similar to the above, a competent consulting engineer would perhaps be called in, and under his professional advice a saving probably might be effected in some cases, which would lead to the same result while still retaining the independent power. The differences are frequently due to the conditions of use rather than improper management. The question seems to hinge almost entirely on the cost of local distribution, and it is just at this point that the project of electrical transmission to Buffalo has come to a halt. The power company has fixed its rates at the power-house, according to various authorities quoted, at $10 per year for undeveloped power, $13 at the top of the shaft, and $18 at the dynamo terminals, evidently laying aside for future consideration the rather complex problem of meeting the requirements of miscellaneous consumers at a distance. As it stands to-day, the Niagara Falls enterprise is similar to enterprises which have already proven successful at Lowell, Holyoke, and Paterson, except that it is on a much larger scale. All new manufacturing enterprises in this country, unless of a strictly local character, will doubtless be located hereafter, only after thoughtful consideration of the great advantages at Niagara.

* It is understood that all contracts for power are based by the Cataract Company upon the maximum which may be reached at any time by the consumer.

EDUCATION OF MECHANICAL ENGINEERS.

AIM AND SCOPE OF THE ENGINEERING COLLEGES.

By R. H. Thurston.

ENGINEERING schools of the higher class have now come to be grouped among the professional schools, which once included only law, medicine and theology. In fact, as President Jordan has remarked, they are coming to represent the highest and most exacting of all grades of professional work, and the young engineer-novice, graduating from a first-class engineering school, has gone through a severer ordeal, has been given a sharper discipline, has acquired more of fact and real learning, in the course of his 4 years of steady and arduous application, than is given, or can be given, in the best existing schools of the older types. His course of instruction demands, frequently, if not usually, higher work in preparation; it is longer by from 1 to 3 years; it involves more severe labor in mathematics and in the physical and applied sciences; and includes, as a rule, as much, if not more, linguistic study. Competition is sharp, in the professional school and outside it; and the elimination of the ill-prepared and unfit is merciless. Few men enter the profession of engineering through such schools, except after 4 years or more of hard work, or unless possessed of some talent for the chosen field of life-work. The drones, the naturally incompetent, and the dissipated are weeded out of schools of this class with far greater effectiveness than from any other professional schools*; and the same is in large degree true of the professional societies, entrance to which is always considered important in later years. It may be fairly claimed that, although often narrow, and perhaps even narrowing, the engineering education of to-day, and in the best class of schools in the United States, is representative of the highest work performed in professional schools, and that the young engineer leaving these schools is a better trained man, professionally, than the graduate of any other professional school. He also possesses a more extensive and practically useful knowledge of the physical and mathematical sciences than any other, and usually has a better hold upon scientific methods of practice, and is more familiar with all the arts subsidiary to his profession. Laboratories and workshops afford him the opportunity to learn his profession by its practice

* Of the candidates admitted to the best engineering schools, often not more than one-third finally graduate.

in these departments. His "clinics" are even more varied and helpful than are those of the medical schools.

The mechanical engineering school confines itself, as nearly as may be, to purely professional instruction in that branch of the profession and its introductory and subsidiary departments. The point at which it shall begin its work is very generally dependent upon the character and the curriculum of the preparatory schools from which its students must be drawn, and its work begins where theirs ceases,—with the higher mathematics and the natural sciences in their special applications. What is desirable in its curriculum is a question to be settled finally by the profession at large; what is practicable is determined by its faculty and the preparatory schools. That school is best which most nearly reaches such a position as enables it to comply with the demands of the profession, and this, in turn, means that which makes the largest demands upon candidates for admission; for no engineering school has yet reached such a position that it can confine itself absolutely to professional work. The proper scope of the professional school, in engineering, is that which sends out its graduates versed in all the fundamental principles of the sciences and all the technical applications of mathematics, physics, chemistry, and mechanics which find general use in the art of engineering, together with such practical familiarity with the subsidiary arts as will enable the young man to enter his chosen profession well-equipped with all that is needed to give him prompt introduction into real work and to prepare him to solve every scientific problem which may arise.

The best-equipped schools of mechanical engineering, for example, carry their students through the usual college work in mathematics, the natural sciences, and the modern languages, into those higher departments of applied science which constitute the theory of all engineering, and into practical, systematic, carefully-planned work in the chemical and physical laboratories, in the newly-inaugurated "mechanical laboratory" of "experimental engineering," in draughting rooms, and even in workshops of the major trades. The backbone of their scientific work is a strong course of instruction in applied mechanics in their junior, or even, as in the course supervised by the writer, in their sophomore year, which study gives solid foundation for the laboratory work, in physics, in chemistry, and in engineering, of the junior and senior years of a 4 years' course. In these schools, the ordinary college course in science is simply a beginning, and the student must be carried forward and upward into the higher realms of experiment and research.

Every important school of mechanical engineering now gives instruction in mechanical drawing, and in shopwork, four years, uninter-

ruptedly. The purpose and the result are the acquirement of practical skill in the use of the tools of the profession and of its subsidiary trades, and the ability to apply the exact methods of the laboratories of science to the solution of every professional problem met with in their application in professional work.

In a well-equipped school and with able teachers the progress of the young man who is naturally suited to the work is extraordinarily rapid and fruitful. Even in the instruction in manual training,—now a generally important division of the work,—the student, under the tuition of an expert, and following the systematic course laid out for him, becomes singularly expert in a wonderfully short time. The equivalent of a few days' work makes him a good smith, and he welds iron with facility and certainty; the equivalent of a few weeks' work at the anvil makes him a good worker in steel, and he makes and tempers his own tools with entire success. In the foundry he quickly learns the principles of his art, and it becomes difficult to find a pattern that he cannot handle. In woodworking and machine-shop practice he quickly learns to handle tools with the ease and skill of an "old hand." All this is done, not to make him a good mechanic in the usual sense, or to teach him a trade, but to enable him to design intelligently, to criticise good and bad work, to indicate the best methods of doing the work directed by him, and to guide the workman intelligently. Nevertheless, this knowledge and skill come into use in numberless cases in which the young engineer finds himself unable to secure the aid of a skilled workman. One young man writes me that he has just saved hundreds of dollars, at a western mining town, by welding up a broken valve-stem that must otherwise have been sent hundreds of miles and caused days of delay; another tells of his successful readjustment of the steam-distribution and the speed of an engine, with the result of securing a doubled power and consequently doubled output of a stamp-mill, in a location where it was thus possible to increase the earning power of the establishment by many thousands of dollars every year.

The mechanical engineering school has thus come to be, not only extensive in its curriculum, exceptionally high in grade, and exceedingly exacting in its requirements, but enormously costly in equipment and in operation. The larger and higher of these schools usually operate, as a piece of scientific apparatus, an "experimental steam-engine" representing $10,000 or $15,000 and working up to perhaps 200 h. p. in some cases, and costing large sums daily for its operation. In an inventory under the hand of the writer are listed fifteen engines of various classes—and more are said to be needed. To-day an independent school can hardly make a beginning in this

field with less than $1,000,000. Even if connected with an existing university under satisfactory conditions of mutual help, $500,000 will hardly satisfy the demands which it is intended to meet; and, when graduate schools of special departments, as of marine, of electrical, and of railway or textile engineering, are to be sustained, $5000 to $10,000 a year, each, must be further provided for their support.

The costs to the student are, of course, a minute fraction, usually, of the total costs of operation. The school pays out from $300 to $500 per student, if of the highest grade; the pupil is charged from $200 down to zero, in different schools, for his tuition and costs of material. The State universities and their technical schools seldom make any charge, and, aside from tuition fees, there is a wonderful variation in the expenditures of students. One student waits on table, takes charge of furnaces in the neighbors' houses, or otherwise earns a few dollars weekly, and, living on oatmeal, with a little canned meat, and doing his own cooking on an oil stove in his garret-room, lives and works hard on from $100 to $200 a year. The son of people of moderate means expends $500; the well-to-do young man from 50 to 100 per cent. more; while the foolish son of more foolish, but wealthier, parents spends from $1000 to $3000 or more, mainly on his follies. Number one of our list usually forges ahead, and stands, ultimately, in the front rank in the profession. The last-mentioned youth either drops out of his class, or, later, lounges at the foot of the ladder, while his perhaps despised rival climbs to the top.

A broad and liberal education, and even a classical education, has its value, professionally as well as in the making of the man. On reaching a certain point in his professional career, other things equal, that man who can best meet intelligent and cultured men on their own level secures the highest and best professional line of practice. Social qualities, intellectual ability, solid learning, are effective reinforcements of the business side of life. James Watt was not simply a great inventor and a great mechanic; he was a learned man and a companion of the great men of his time in every department. His professional success and, more important still, perhaps, his beautiful private life and the glory of his later years, were largely based upon his social and intellectual attainments. "*Wisdom* is the principal thing; therefore get wisdom: and, with all thy getting, get understanding. Exalt her, and she shall promote thee: she shall bring thee to honor, when thou dost embrace her."

"The aim of engineering schools" is to offer to intelligent, ambitious, well-prepared young men, who have a talent for the profession of engineering,—and to none other,—such a system of special instruction, of elementary professional training, and of practice in the appli-

cation of scientific principles and methods in the essential branches of the arts and trades contributory to professional work, as will enable such youth to successfully enter, and to make easy and rapid progress in, the chosen field of life-work. The best of such schools are to day bringing all the arts, all the sciences, and all the literatures under contribution, in so far as each and all may be found valuable, in the promotion of what is coming to be one of the most truly learned, if not actually the most learned, of all the professions. Old as Tubal Cain; distinguished by a membership including Hero and Archimedes, Da Vinci and the second Marquis of Worcester, and a thousand later and no less great men; advancing as is no other profession to-day; contributing to the promotion of the comfort and happiness of the world as does no other department of human labor and thought,—this profession is now coming to possess the means of training its youth up to a higher standard than is, or ever was, attained by any other profession, and it is doing, more and more, the work of the world. In this great field, and to these great ends, the schools of mechanical engineering are to-day contributing most magnificently. Future years will see, it may well be hoped and believed, even more admirable work performed in the building-up of the industries, in their diversification, in promoting the physical and moral welfare of the people, and in giving the nation prosperity, power, unity, and noble aims.

EDUCATION OF MECHANICAL ENGINEERS.

II—THE BEARING OF SHOP PRACTICE.

By Charles E. Emery.

A MAN'S success in life depends, first, on his natural ability, and, second, on what he knows. An able man may start with practical work, and by industry and earnest endeavor rise through the various grades, become useful, say, as an engineer, and afterwards supplement his education by hard study, when necessary, and attain some degree of eminence; but this will be accomplished with an enormous waste of time and energy. The success of so-called self-made men should not encourage deliberate attempts to repeat such experiences. Many such men have had opportunities, now rarely available, to engage in practical work which of itself taught valuable lessons. Some started their education before the technical school as now known was in existence, and obtained really a good preliminary education in the many excellent academies of the country, which frequently taught practical surveying at least, and thus started the young man in life fairly well equipped for one branch of engineering, when its duties were less exacting than at present. Other successful engineers entered the profession late in life, after having the mental training due to study and experience in another profession. Others, in addition to early experiences, had learned habits of discipline and the necessity of study in connection with practical experience in the United States navy.

Of late years the technical school has supplied all that can be desired in an educational way; but some young men to whom study has been distasteful refer to the success of self-made men as a reason for not entering the technical schools, and many, without proper guidance, start work in some subordinate position in a shop or surveying party, with the expectation that they will continue to study, or at least "get along as well as others have done," unaware of the difficulties that the older men had to surmount, and without realizing that they must rise in competition with educated men from the technical schools, many of whom, after a little practical experience, will be more desirable additions to the profession than themselves. The majority of those who abandon their studies never return to them. They become satisfied with such progress as they can make, establish a social position with a class of people of the same kind, and gradually drop out of sight. A few of marked ability may ascertain their own

deficiencies and be able to throw off the fascination of real progress in actual work, prepare for and attend a technical school at a somewhat advanced age, and win success in the end.

It has been pointed out that the graduates of technical schools are, as a rule, not immediately as useful as men who have risen from the shops, and, without realizing how much more the educated man knows when he has been taught how to apply it, some critics have arraigned the whole system of technical education, particularly the order in which principles and practice are taught. Some have held that, after preliminary study of English branches in childhood, lads should be put at practical work with the expectation that, while so doing, they would appreciate their lack of general information and at a later period of life find the higher course attractive, as they would then intuitively apply the principles to their former experiences, and see the advantages to be attained in understanding more difficult problems. It was hoped that in this way the necessity of much of the exertion required to keep students up to their work would be avoided, and perhaps some time saved eventually in accomplishing a certain degree of instruction and experience. Experienced observers, however, know that few average lads would use their reason in this way.

All interested would probably agree that, if it were possible to double the length of a course and have the school in a large manufactory, principles and practice could be systematically combined so that the students would be fairly proficient in both. Now about the same time must be occupied, but in different places. As matters stand, it appears to the writer that there are decided advantages in completing the regular course of study in the technical schools in comparatively early life, and then blending the practical participation and experience which are necessarily part of an education into the professional practice which follows in due course. If there were no other reasons, it is sufficient to say that the earlier years of a young man's life should be spent, when possible, among gentlemen, where, in a circle of culture and refinement, even the deficiencies of home training would be supplemented, and the manner and bearing of the inchoate man become so firmly fixed that the rough external contacts of practical life would not change them.

So long as technical instruction is confined to a four years' course, the greater part of that period should be occupied in the study of principles. It is useless to talk about continuing study afterward, unless the principles are so thoroughly grounded that the higher developments are immediately understood in such way that they can be applied at once with advantage. Moreover, the experiences of earlier work will so occupy the mind that it will be impossible to continue

study. The work in the technical school should not, however, be confined entirely to the study of principles. There should be combined therewith instruction in the rudiments of practical work, which can generally be introduced in such a way as to furnish largely the exercise and diversion of mind which is necessary to all students between their periods of study. The principal advantages that our ancestors of the stone age had over other animals was that reason enabled them to make tools,—first weapons for attack and defence, then implements for tillage of the soil. Finally they discovered how to make a fire, thus accidentally developing metallurgical work and thereby improving their tools, until, in short, as engineers, they wrought out civilization. The engineer of the present day should further advance civilization by learning the use of tools thus developed until he knows their possibilities in the hands of workmen. He should start with ordinary hand tools to increase his physical strength and steady his nerves, such as the cold chisel, the hammer, and the file ; he should ascertain the possibilities of the blacksmith's forge and the routine of casting metals. After attaining a fair degree of skill therewith, he will more readily appreciate the advantages of machine tools, and the danger is that he will become so much infatuated with them that other features of importance will be neglected. Ordinarily he should use the lathe until he can make an accurate fit, and other tools sufficiently to know the object of their movements and form a conception of their capacity in connection with inspection of work elsewhere. It is undesirable to go further and construct machinery for actual use or sale in connection with school work, for the simple reason that there is so much else which needs attention in the limited time available.

It is particularly essential that the student in mechanical engineering become a good draughtsman and be employed in actual design, after he has learned its principles and can properly provide mechanical movements to accomplish the particular purposes and distribute the metal of a structure so as to secure minimum weight and proper strength for the computed strains. It is to be regretted that very few young men from the schools have the taste for this branch that they should. It is really the foundation of progress in mechanical engineering. The mechanical engineer should also know the construction and purposes of the ordinary surveying instruments of the civil engineer, and have some reasonable skill in their operation. He should know, similarly, the details of electric machinery, understand how to use it with due caution, and be able to utilize its powers to the best advantage, and to keep it in order.

In every branch of engineering the developments are in the direction of more important mechanical structures, requiring the skilled

judgment of a mechanical engineer. The locks of a canal are now being so much enlarged that they must be made of iron and steel instead of wood, and moved by powerful engines, hydraulic or otherwise. Railroads, railroad shops, and electric-power plants are now great hives of mechanical industry. The modern ship, whether for naval or merchant service, is contructed of steel or iron, requires for its propulsion immense steam engines and boilers, and has come to have all the modern conveniences of a great city in a single structure, such as refrigerating plants, electric lighting, artificial ventilation, etc. The modern buildings require frames of steel, high-spced elevators, and a great amount of machinery in the basement to operate the elevators, furnish electric lights, and keep up the water supply. It is impossible for the mechanical engineer to learn at school all the details of civil engineering work, naval engineering, electrical engineering, and architecture, but he may learn the principles which underlie all branches of engineering, and in a general sense what it is possible to accomplish with each, and so fit himself to design and superintend the construction of any mechanical structure in either of the departments named.

In addition to the above, it is desirable that an engineer should know something more than his specialty. He has duties to society and to his friends. The old saying, "know something of everything and everything of something," is valuable, but it is necessary for a man, not only to know his business thoroughly, but to be able to impress others with the fact. It is well for a technical man to have a superficial education like that of some women, in addition to his technical knowledge, and thus know how to be entertaining without exhausting one's life with details.

It is thought that engineers of all classes can receive the same education until near the end of their college course. Few young men know early in life what particular branch of engineering they will follow; so it is desirable that the principles and general information to be imparted during the first few years of the course should be adapted to all the branches. It would be of advantage to have all kinds of engineers know the use of tools to the extent previously mentioned. All classes could probably take the same course the first year, and in the second year become more familiar with the operation of the devices peculiar to the chosen branch. Later, combined relaxation, pleasure, and exercise out of the hours of study would be taken up with laboratory work, which, for a mechanical engineer, would include experiments on the strength of materials, and with steam and gas engines, pumps, and the various kinds of apparatus usually employed. The present method of writing a thesis on some particular

work of a practical nature in regard to which proper details can be obtained is very valuable, and frequently men of the more advanced classes procure and record information of this kind which is valuable to their seniors in after years.

In conclusion, the mechanical engineer should let no opportunity slip to learn all that can directly or collaterally benefit him in the prosecution of different kinds of work. This suggestion applies not only to the period of a college course, but to the *quasi* apprenticeship to practical work which must follow. The enormous amount of detail which it is necessary to acquire in order to be proficient in one division of one branch of engineering makes it necessary above everything that the student make the best of his opportunity during his course in the technical school to obtain a knowledge of principles and their method of application, with general information in the way of reference to descriptions of works of a special kind, so that, whatever problem may be submitted in after years, the principles can be readily comprehended. A habit of close observation in the direction one wishes to practise will, with these precautions, enable the young engineer to be of advantage to others during the early part of his career, and to himself and his clients as soon as he undertakes business for himself.

EDUCATION OF MECHANICAL ENGINEERS.

III.—VALUE OF THE MANUAL TRAINING SCHOOLS.

By A. E. Outerbridge, Jr.

Lessons—through and by work—through and from life—are by far the most impressive and intelligible, and most continuously and intensively progressive, both in themselves and in their effect on the learner. Notwithstanding this, children – mankind indeed—are too much and too variously concerned with aimless and purposeless pursuits, and too little with work. . . . Experience shows that external physical, productive activity, interspersed in intellectual work, strengthens, not only the body, but in a very marked degree the mind in its various phases of development, so that the mind, after such a refreshing work-bath (I can find no better name), enters upon its intellectual pursuits with new vigor and life.—*Froebel's Education of Man.*

THE aim of education—especially technical education—should be, first, to provide a thorough, general training or groundwork in elementary principles, and then to develop individual talent, so that, when the student enters the workshop of the industrial world, this latent quality may have become energized.

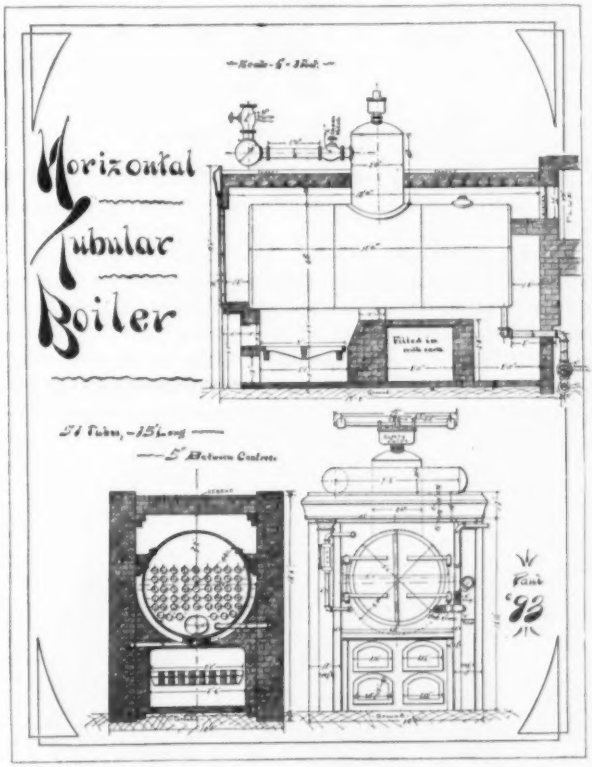
The evolution of the new conception of technical elementary education, to which the incomplete and misleading name of "manual training" has been given, has progressed with wonderful strides during the past few years, especially in America. Its history and the conditions and influences that have powerfully stimulated its growth in the United States is an interesting and tempting theme, but the limit of space allotted to me precludes my entering upon it.

Respecting the special topic which I have been requested to discuss in the ENGINEERING MAGAZINE,—*viz.*, manual training as a starting-point in the education of mechanical engineers,—I may say that I have heretofore contended that the aim of manual-training schools should be "to produce bright young workmen, not mechanical engineers; men, not officers."

This view does not conflict with the arguments that I am now about to present, but harmonizes therewith, for the graduate of the manual-training school is, or should be, well fitted, by reason of the facile instruction he has received in practical manipulations and of the trend of his mental training, to begin the study of technical principles; not only has his hand become educated, but his eye has been trained and his mind developed along the line of his future calling.

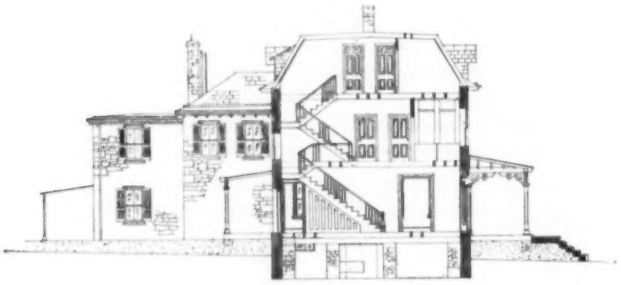
As long ago as 1851 night schools for artisans were established at the Spring Garden Institute in Philadelphia, the teachers being draughtsmen and others from the Baldwin Locomotive Works in the immediate vicinity.

The famous Russian exhibit at the Centennial Exposition gave a great impetus to the study of manual training in the United States,



MACHINE DESIGN. THIRD YEAR.

and the mechanical handiwork schools of the Spring Garden Institute were soon afterwards established, on a modest scale, under the supervision of Lieut. Crawford of the navy. Girard College followed this lead, and in 1885 manual training was made an integral part of the public school system of Philadelphia through the establishment

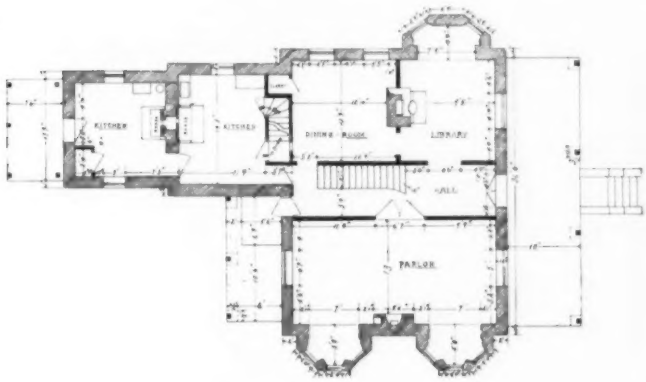


ARCHITECTURAL DRAWING. THIRD YEAR.

(under the auspices of a special committee of the board of education) of the "Central Manual Training School," having the grade of a high school.

Beginning with one hundred and twenty students, who were graduates of the grammar schools, it soon outgrew its quarters; extensive enlargements were made, and the entire plant was then duplicated by the establishment of the "North-East Manual Training School," of like grade and capacity, in a different section of the city. A plan for a grand extension of this successful experiment on a broader scope is now under contemplation. As the schools named are typi-

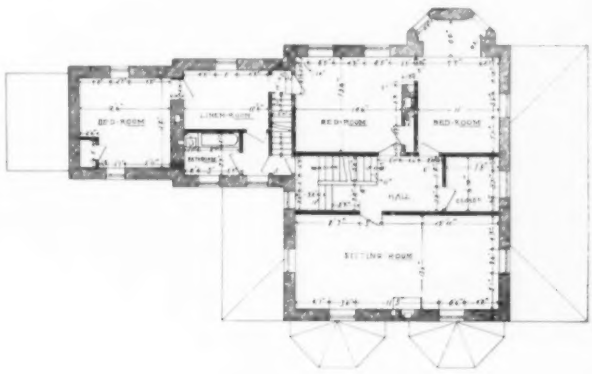
ARCHITECTURAL DRAWING. THIRD YEAR.



ARCHITECTURAL DRAWING. THIRD YEAR.

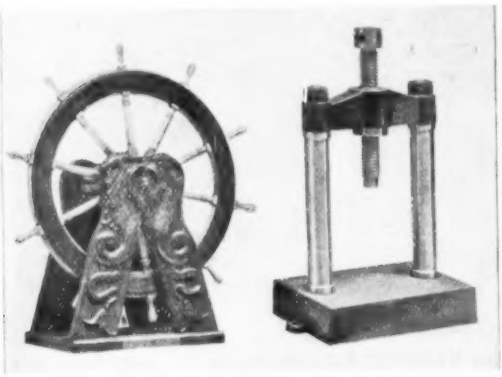
cal, and are essentially identical in equipment, the following general description will apply to either or both.

The faculty of the Central School comprises a principal and fifteen instructors upon the following subjects: mathematics; physics; chemistry and natural history; constructive, free hand, architectural drawing and designing; English language and literature; German and French; history and economics; joinery, turning, and parquetry; moulding, smithing, and ornamental iron work; chipping, filing, and fitting; pattern-making, turning, and wood-carving; constructive work, machine tools.

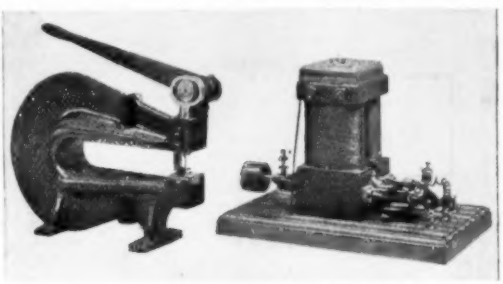


ARCHITECTURAL DRAWING. THIRD YEAR.

About seven hundred students now tax to the utmost the capacity of the two institutions: they are divided into classes of twenty-five, and, beginning with the draughting room as the basis of the entire system, the students first make in note-books rough copies of simple mechanical designs. Working drawings are then made, and, when these are approved by the instructor, the boy constructs, in the course of a few weeks, his first "pattern" in wood from his own drawing, having received, in the interim, elementary instruction in the use of the chisel, plane, etc. When his pattern is approved, he makes a sand mould therefrom (having also, in the meantime, received instruction in the tempering of sand and the use of the moulder's simple tools). When he has successfully moulded the design in "green sand," he makes a casting of the same in metal; this must be free from "blow holes" and other defects known to found ers. When the casting has been approved by the instructor, the boy passes into the "chipping shop," where he is taught the crude work of dressing castings with the cold chisel and file, cast iron and other metal practice-blocks being provided for the purpose.



MECHANICAL CONSTRUCTION. THIRD YEAR.



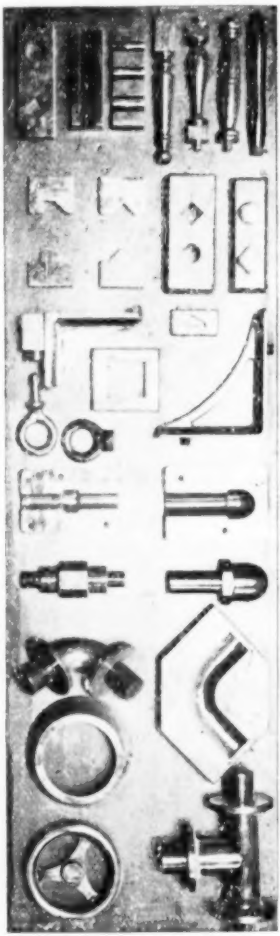
MECHANICAL CONSTRUCTION. THIRD YEAR.

The standing of each scholar is graded by the record of his work,

WOOD CARVING. FIRST YEAR. PARQUETRY.

WOOD CARVING. SECOND YEAR.

COURSE IN WOOD-WORK.
FIRST YEAR.



COURSE IN PATTERN-MAKING.
SECOND YEAR.

and a certain standard of excellence is required before the next step can be taken.

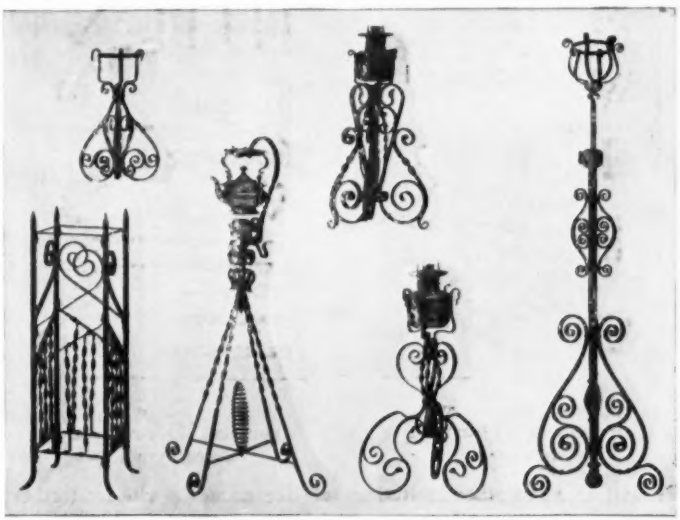
The course is of 3 years' duration, and, as the boy progresses, the operations become more difficult; for example, the mechanical work-

ing drawing is more elaborate, because the pattern to be made therefrom is more complicated; the moulding requires more skill, because of the shape of the pattern, use of cores, etc.; and the machine work increases in complexity of detail in like measure.

It is not the intention to expend the time of the boys in manufacturing articles of use or ornament: they are taught principles and practice which will enable them in after life to apply knowledge to specific purposes. Many of the advanced students, however, have proved themselves competent designers and constructors of machine tools and other appliances, and a number of the tools in practical use at the schools were designed and built by the students.

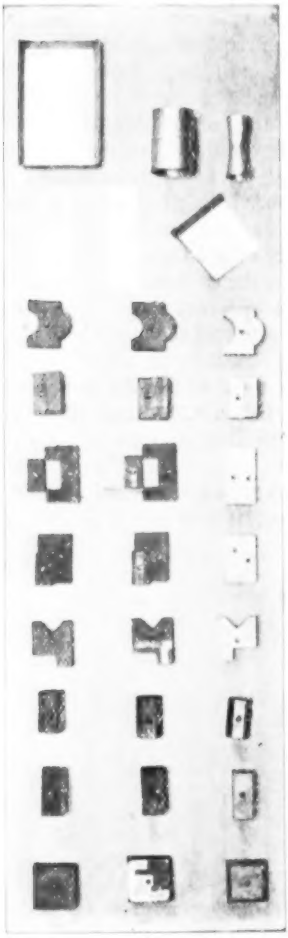
The literary feature of the curriculum is not dwelt upon here. Suffice it to say that in the academic department the method of study and research is made to harmonize with scientific principles, the effort being "to lay a broad foundation upon which the best superstructure of intellectual cultivation can be built." More hours per week are devoted to literary and theoretical study than to practical work.

Diplomas are granted to students who have successfully finished the 3 years' course; these admit the graduates to the University of

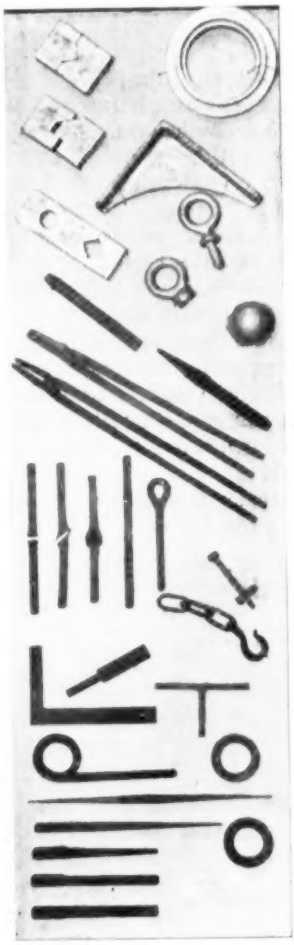


ORNAMENTAL IRON-WORK. SECOND YEAR.

This is some of the boys' work which they may own upon their paying for the material used.



COURSE IN CHIPPING, FILING, FITTING AND TIN-SMITHING. FIRST YEAR.



COURSE IN SMITHING AND MOULDING. SECOND YEAR.

Pennsylvania and other institutions of like standing without further examination. Prize scholarships are also granted by the University, providing free tuition to manual training school pupils having the highest averages.

That the school fosters a desire for higher education is shown by the fact that more than 25 per cent. of the graduates are students in colleges, universities, or technical schools, and about 70 per cent. are engaged in pursuits in which a high order of intelligence, as well as manual skill, is required.

A recently-prepared list of graduates with their occupations show that thirty-four are now serving as managers, superintendents, and foremen of electric power and lighting plants, manufactories, etc.; sixteen are teachers in manual training and other schools; thirteen are electrical engineers; seven are mechanical engineers; ten are architects; six are civil engineers; five are physicians; five are chemists (with steel works, etc.); fifty-four are draughtsmen; forty-five are engaged in various kinds of electrical work; and seven are law students.

In considering the question whether manual training, such as that afforded to students at the schools in Philadelphia, is adapted to the preparatory or more advanced education of the mechanical engineer, we must recognize the fact that this profession has broadened greatly within a generation, and shows an evident tendency to "specialization."

The training which sufficed both for the preparatory and the advanced education of the mechanical engineer 20 years ago is now inadequate. The sciences of electric lighting, development and distribution of electric power, and other practical applications of electric force produced by mechanical means, have been developed within the brief period named.

Modern improved methods of manufacture of structural iron and steel, and the application of these metals to the construction of buildings and other purposes, have caused a complete revolution, practically creating a new branch of mechanical engineering. Scientific filtration is a new science, and sanitary plumbing, disposal of sewage and garbage, and a host of other professional activities of equal importance and novelty now come within the required attainments of the mechanical engineer.

The fundamental principles which underlie the forces of nature are susceptible of simple demonstration, and these should be thoroughly taught, and are taught in the manual training schools; they are, in like manner, susceptible of practical elucidation through the aid of machinery. It is even possible to closely imitate the mysterious magnetic forces, and to illustrate their action by means of Professor Bjerkness's* pneumatic apparatus, which is unknown, I believe, in this country;

* University of Christiania, Norway.

the idea of "mystery" should be eliminated in the study of nature's forces, and the student should be made to comprehend electric force as easily as he can comprehend mechanical force. The manual training school is aiming to do this, and the boy who winds an armature and constructs a model dynamo or motor has ever afterwards a degree of intimate familiarity with the nature of the forces called into play by the operation of the machine which no amount of theoretical or mathematical study can give.

The conclusion at which I have arrived, after study of the subject, aided by observation of the working of the Philadelphia schools, is that manual training, as a starting-point in the education of mechanical engineers, is a scientific invention and intellectual discovery worthy to rank with many other original discoveries of the age, and is destined to produce equally beneficial results in the future. It is, moreover, a discovery which has passed the stage of abstract discussion; the movement is rapidly taking firm hold in new localities, and enlarging wherever it has obtained a footing. Lest we might imagine that there is danger of overdoing the work, it may be stated that in Philadelphia,—the birthplace of manual training in America and foremost in its development,—the facilities of these schools extend to less than 3 per cent. of the boys in the public schools. Less than 1 per cent. of the school boys in the United States continue in school long enough to reach the grade of the high school; indeed, the percentage that attends even the grammar school is woefully small. Among other advantages possessed by the manual training school is the important one that it tends to prolong the school life of boys, and its expansion will prove of inestimable advantage, not only to the training of mechanical engineers, but in all walks of life.

THE INVESTIGATION OF PUBLIC WATER SUPPLIES.

By Floyd Davis.

ONE of the most important factors in the prolongation of life and preservation of health in any community is a pure and wholesome water supply. The necessity of measures which enable municipal authorities to secure such water, in quantities to meet all demands, is now fully recognized by every intelligent citizen, who also knows that pure sources of supply can generally be determined only by a thorough and careful investigation. As the population of our country increases, the sources of contamination likewise multiply; so year after year it becomes more and more difficult to secure an adequate supply of water for cities and towns that shall be entirely free from dangerous impurity. In mountainous regions, where the conditions for self-purification are most favorable, we generally find the purest waters, in great abundance; yet in the Mississippi valley, where the streams are generally sluggish and frequently heavily laden with organic impurity, and in the eastern States, where the rivers are sewer polluted, the problem of securing pure water is difficult, and it is sometimes almost impossible with limited means to furnish a supply that is beyond dispute in its quality.

Many of our cities and towns lie adjacent to public water courses, from which the water, polluted or otherwise, is pumped through mains, without proper purification, to be drunk by the people. Under such a disregard for sanitary considerations it is not strange that we are still maintaining in some parts of the country a typhoid fever rate higher than that prevailing in any other civilized country. Our typhoid death-rate is too frequently many-fold what it is in some European cities, like London and Berlin, which have expended millions of dollars to secure for their citizens a pure and wholesome supply of filtered water.

The ideal water for manufacturing and domestic purposes is distilled, and the amount of impurities, both inorganic and organic, found in natural water is, therefore, a measure of its purity. It is rare that the mineral constituents have any marked effect on the quality of a water for drinking, since the poisonous compounds of barium, iron, zinc, copper, lead, and arsenic, which may exist in it, are not often found in sources that are available for the supply of cities and towns; and in the sanitary investigation of a water supply we do

not usually look for these substances. But the mineral constituents have a bearing upon the use of a water for boiler and manufacturing purposes. Its suitability for the generation of steam is determined mainly by the amount of lime, magnesia, and mineral acids which it may contain, since these bases incrust the boiler and the acids corrode it. Magnesium chlorid is especially objectionable. The mineral salts also characterize a water for manufacturing purposes, since a hard water containing much iron is unsuited for the manufacture of starch; a water having much magnesium in it is not desirable in the manufacture of beer; while water for distilleries should be as pure as possible.

These are considerations of importance only for particular purposes, but every public water supply must be used domestically by large numbers of people, and the substances which vitiate it for such purpose are of greatest importance in its sanitary investigation. They are organic, both vegetable and animal, and exist in different proportions in all natural waters that have any communication with the surface of the soil. The manner in which they gain access to water, and their relations to health and disease, have been discussed in a former number of this magazine.* Suffice it, therefore, to say here that decaying animal matter is indirectly far more dangerous than decaying vegetation, for it is from animal sources that the infectious bacteria, now considered the real agents of disease, are mainly derived. Upon the danger from these various impurities is based our classification of water supplies.

Whenever I am called upon to investigate the water supply of a city, which may include wells and other sources, I generally classify waters under five divisions, as follows:

1. *Excellent waters*, or those which are so pure and free from suspended matter that aëration and filtration would scarcely improve them. Aërated distilled water and the water from some springs in granite regions belong to this class, but it is rare that a chemist has to investigate them.

2. *Permissible waters*, or those which can be used constantly for all domestic purposes, without any danger of injurious effects. They are waters which, however, can be improved by better methods of storage, or by a thorough filtration. Nearly all drinking waters belong to this class.

3. *Suspicious waters*, or those which are liable at any time to produce ill-effects, or to become so polluted by an influx of filth that they may become bad, or even very dangerous. I always recommend that suspicious waters be first thoroughly boiled, and then filtered, before being used for drinking.

* December, 1891.

4. *Bad waters*, or those which are sufficiently polluted to render them unfit for domestic use. These may not be immediately productive of disease, but I believe that they lower the vitality of the system and render it very susceptible of zymotic infection. On account of the nature of their pollution, common intelligence should prevent us from using them.

5. *Very dangerous waters*, or those which are polluted by direct communication with cess-pools or privies, and in which the pollution is of so high a degree that they should be immediately condemned. Such waters are often productive of typhoid fever and other filth diseases.

In passing upon the quality of a public water supply it is, therefore, essential that all water flowing into it which is seriously polluted with sewage should be rejected. There are other waters, not thus polluted, that have a disagreeable taste and odor, and are manifestly unfit for drinking; still, they are sometimes used in public supplies, largely from necessity.

Cisterns and common surface wells are too infrequently used for public purposes to be considered here, and there are few or no apologies for such a supply in any wide-awake town, although from a sanitary standpoint they deserve our most careful consideration. Springs are used as a source of public water supply in many mountainous regions where the topographical conditions are favorable for their utilization, but in other localities ground waters, stored surface waters, rivers, and lakes are generally used. In many parts of Europe several of these waters are introduced into one city, sometimes at great expense. In this country the usual source is the one that is most convenient to adopt, which is somewhat determined by the topographical conditions of the locality. Thus Denver has a delightful water supply furnished by mountain springs and melting snow, supplemented by hundreds of artesian wells; some cities, like Columbus and Des Moines, located near never-failing streams, utilize the ground waters in the adjacent gravel beds; Boston and New York, having no adequate supply of fresh water near by, store in artificial lakes or reservoirs the rainfall on the nearest elevated water shed; some cities, like Cincinnati, St. Louis, and Omaha, situated on rivers, secure their water supply from these natural channels; while other cities, like Cleveland and Chicago, having great lakes at their doors, reach out into these for their waters.

Spring water which flows from subterranean sources is generally pure and wholesome, because from necessity it is free from organic contamination, and, when the springs are remote from the agencies of pollution, their water is certainly our most healthful beverage. It is

so much superior to surface water for domestic use that some cities have incurred great expense to introduce it for a public supply, and in some instances have thus freed themselves of much sickness and a high rate of mortality.

Ground water in regions remote from habitations is generally very pure, and, although it may be, and often is, derived from polluted rivers, yet, owing to its thorough natural filtration, it cannot often be considered unwholesome. Indeed, with the exception of springs and some mountain streams, I consider ground water by far the best general supply for a city, and in the Mississippi valley this can generally be easily obtained. When such water is secured from wells and filtering galleries in beds of gravel above a city, or along a river course some distance from its channel, it is generally clear, sparkling, and nearly free from organic matter. This is especially true when the gravel beds are separated from the surface by an impervious stratum of clay, and the supply of water comes for long distances by filtration from rivers or other inexhaustible sources. Such water owes its purity to sedimentation and thorough filtration, combined with oxidation; for, during the passage of the water from its source to the well or gallery, the suspended decaying organic matter and the bacteria are retained in the soil, while the soluble organic substances are oxidized into harmless inorganic compounds. It is generally superior to artificially purified water, inasmuch as it is rendered pure long before being utilized, while surface water is purified as used.

Stored surface waters, rivers, and lakes may be very similar in their impurities. The former, when gathered on uninhabited water sheds, will contain little else that is harmful than decaying vegetable matter. But rivers are the receptacles of the waste products of the inhabitants of the districts through which they flow, and are sometimes very dangerous to use. When it becomes known that a surface water is in any considerable degree contaminated with the wastings of feed-lots and slaughter-houses, the refuse of manufactories, dead and decaying animals, and the drainage filth of many thousand square miles, it should be avoided; and, when it is further contaminated with sewage, or privy and cesspool drainage, or in any way mixed with the waste products of the human body, its use for drinking and cooking should be prohibited, for some of our most dreaded diseases are now traced to such water supplies.

My reason for rejecting all such water as unfit for human use depends also upon two other principles well-established in all civilized communities. The first is that common decency causes every intelligent person to rebel against the use of sewage-polluted water, for no one but a savage, or a lowly-organized scavenger, will wilfully de-

your the urine, excrement, washings, and filth of man and beast. That such filth is actually finding its way into many rivers is beyond dispute, for the many thousand head of cattle and hogs now kept along our western rivers during the feeding season contribute annually an immense amount of filth to these waters. Tramping the clay soil soon renders it impervious to the rains, and consequently nearly all the filth finds its way in rainy seasons through the small streams into these rivers. In time of high water, there is only little sedimentation of these impurities, and they are carried in suspension and solution down to and past the intake of water works of cities and towns located below. In time of low water much of the heavier suspended matter settles to the bottom of these rivers, there to decay and pollute the water, or to be washed down the stream at the next fall of rain.

The second principle is that, when a water has once become infested with disease germs, it can never be entirely purified, except by distillation or sanitary filtration. Such germs are liable to be contributed to these rivers at any time, should a sporadic case or an epidemic of typhoid fever occur in the drainage area above, and the dejections of the patients go into the river. The impurities in these river waters are such as will favor the multiplication and development of germ life, and the living organisms, instead of disappearing, sometimes become more numerous as the rivers are descended. During high water, when there can be no permanent sedimentation, these waters become constantly more impure in their flow down the river; so, in using them as a source of supply, we must expect to be confronted with all the evil effects that can arise from the sewage and filth that go into them.

From whatever source a public water supply is derived, it should be borne in mind that it will not remain constant in purity throughout a whole season, for there are fluctuations depending upon rainfall, temperature, season, vegetable and animal contamination, and communication with other morbific agents. These variations and the probable degree of contamination of the public water supply should be investigated by the health officers, city physician, or other responsible and capable person, who should communicate his results to the people; and these investigations should extend to the surface wells and other sources of water, which the more ignorant and less fortunate classes are often compelled to use. It is a comparatively easy matter for one somewhat skilled in scientific manipulation to make a few qualitative tests that will enable him to determine with considerable accuracy whether or not a given water is badly polluted. For such examination I usually recommend two tests,—one for chlorine and the other for decaying organic matter.

In most parts of the country away from the sea and salt wells the purest ground and surface waters do not contain more chlorine than suffices to give, with a solution of silver nitrate, a faint opalescence. In testing water with this reagent, its action on a sample of known purity near by should be determined, to use as a guide in comparing other waters. And, whenever an experimental sample shows a decided milkiness with this reagent, then sewage contamination is to be suspected, in proportion to the amount of the precipitate; for sewage, dish-water, cesspool drainage, and other similar polluting agencies generally contain much chlorine. This test is also a valuable means of detecting drainage from a privy-vault into a well. It may be made by first determining the degree of opacity produced in the water by this reagent, and then throwing about 50 lbs. of salt into the vault, together with several barrels of water. After a few days, again examine the well water with a silver solution, and, if there is a noticeable increase of chlorine, contamination is quite certain, because the salt, which contains this element, has probably washed from the vault into the well. This method of testing gives results which will frequently surprise those unfamiliar with the subject.

Decaying organic matter is never found in appreciable quantity in pure water. If to a glassful of such water a few drops of sulphuric acid and a few drops of a dilute solution of potassium permanganate be added, a permanent pink color is produced; but, if the water contains decaying organic matter, then the pink color becomes fainter and finally disappears. In the hands of an expert this is an important test, but it cannot be relied on with a novice, since ferrous sulphate, hydrogen sulphid, and other reducing agents, sometimes present in water, produce similar results. But, when a water shows an excess of chlorine and bleaches potassium permanganate, it is certainly suspicious, and should be analyzed by an expert. My advice in all cases where persons seek counsel is to make the experiments given above, and, if the results are not satisfactory, to send the water to an experienced chemist, with necessary information regarding its source, and have a thorough analysis made.

The most extensive investigation of the quality of a water supply involves questions of a chemical, microscopical, biological, and physiological character, together with an examination of the surroundings of the source of supply; and in all this much depends upon the judgment and experience of the analyst, for water analysis is certainly among the most delicate of all chemical operations, and its proper interpretation requires great experience. The chemical analysis should determine the present and past pollution of water, and distinguish between vegetable and animal matter; the microscope should reveal floating substances,

like fragments of hair, excreta, and other filth derived from surface drainage or sewage, which show at once that the water containing them is loathsome and unfit for domestic use; the bacteriological investigation should be for the purpose of detecting infectious germs, but it is more frequently to determine the number of micro-organisms in a given volume of water; while the physiological test should be made in order to afford opportunity for studying the effect of the water on the lower mammals. Since bacteria are now believed to be the direct or indirect agents of all zymotic diseases, the determination of the conditions favorable for their development, as shown by the chemist, or of their actual existence in water, as shown by the bacteriologist, is the real aim of sanitary water analysis. Without discussing the relative importance of the chemical, microscopical, bacteriological, and physiological examinations, it is only necessary to say here that, whenever a chemical and microscopical analysis reveals an excess of filth or sewage in a water, its use should be discontinued without further investigation; for the time required for a thorough bacteriological analysis renders such too expensive for general use, to say nothing of the common failure to recognize the infectious germs. The most experienced water analysts look more to the chemical and miscroscopical results than to the bacteriological, because the chemical and microscopical methods of study are highly perfected, while the bacteriological methods are yet in a chaotic state so far as utility is concerned.

It is my opinion that the past history and associations of many waters are often sufficient to condemn them, no matter how free they may seem to be from organic impurity; and it is not always necessary to make a laboratory investigation to condemn some of the polluted ones. Then, too, every analyst knows, or should know, the importance of having a thorough knowledge of the surroundings of the source of supply, before giving an opinion of the quality of a water for drinking; and I believe that no competent chemist will claim that a water high in chlorids and nitrates, although organically quite pure, is good, without a knowledge of the agencies which may pollute it. Inexperienced chemists are in error in sometimes relying wholly, in testing a water, upon the Wanklyn process, which determines the free and albuminoid ammonia, but gives no knowledge of its past history, or of the products of oxidation of its organic matter. Any analyst who finds a water contaminated beyond a reasonable limit of safety is justified in condemning it; but, because he may fail to find any of the immediate products of decomposition of organic matter, he would not, in my judgment, be warranted in pronouncing such water good, unless he knows that such products have never existed in it; for it frequently happens that a water having direct communication through the soil

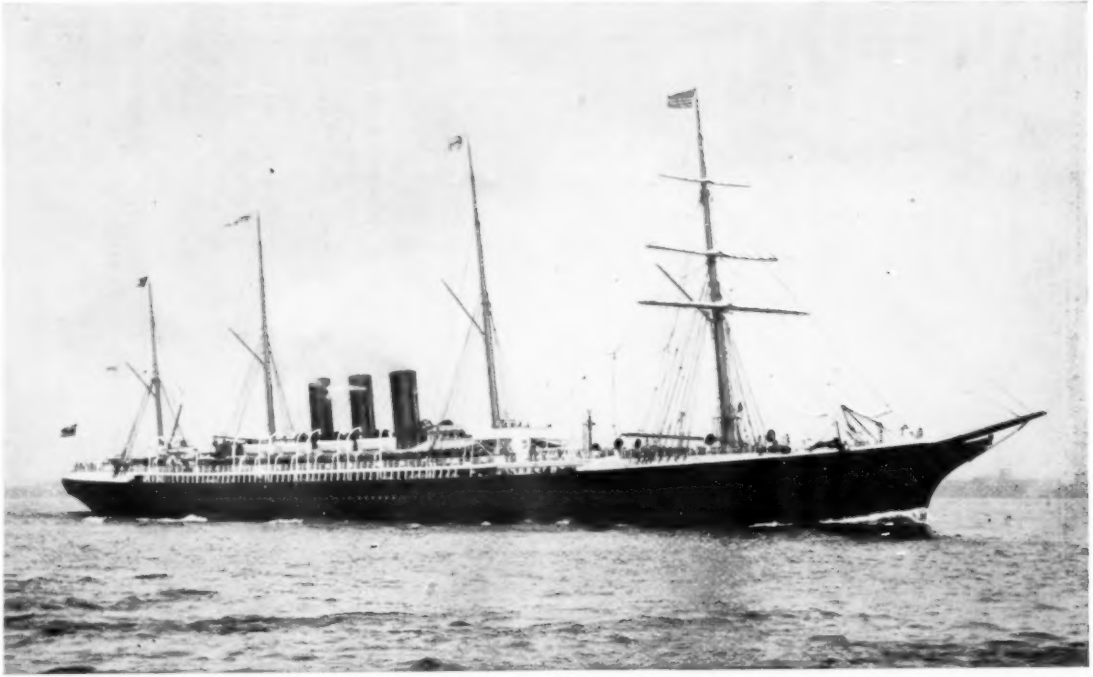
with cesspools and privies has but little organic matter in it. The same is true when lime is used to disinfect a privy-vault. In all such cases the amount of chlorids and nitrates in the water is excessively high, and generally the total solids and loss on ignition are also large. Still, this is not different from what we often find in good mineral waters; and a chemist who relies solely on his laboratory determinations might claim that such water is good and safely potable, while in fact it may be a most dangerous beverage and badly infested with disease germs. Thus it is that an opinion of the quality of a water should be given only after a careful consideration of the surroundings of the source of supply. More than this, I believe that no chemist should, and no experienced reputable chemist would, venture a *decisive* opinion as to the purity and wholesomeness of a water supply for a city or town without a *personal* inspection of the topography of the surrounding territory. It is unwise, if not impossible, to predicate an opinion upon the investigation and report of inexperienced men, or to determine the present and prospective soil pollution without a personal inspection of the entire drainage area.

England formerly led the world in the investigation of public water supplies, but in recent years Massachusetts has given us classic results in this as well as in the filtration of water; so in this country we are just beginning to realize that pure water, which was once the luxury of the few, is now the necessity and pleasure of the many. The benefits which have resulted from these and other investigations are attested by the healthful development and increased civilization of our race; for it is now admitted by all competent judges that the progress made by the inhabitants of manufacturing towns, in decency, cleanliness, self-respect, and morality, since the introduction of a pure public water supply, is as striking as the improvement in their health, which shows that pure water is a great moral as well as hygienic agent.

THE GREAT MODERN TRANSATLANTIC STEAMSHIPS.

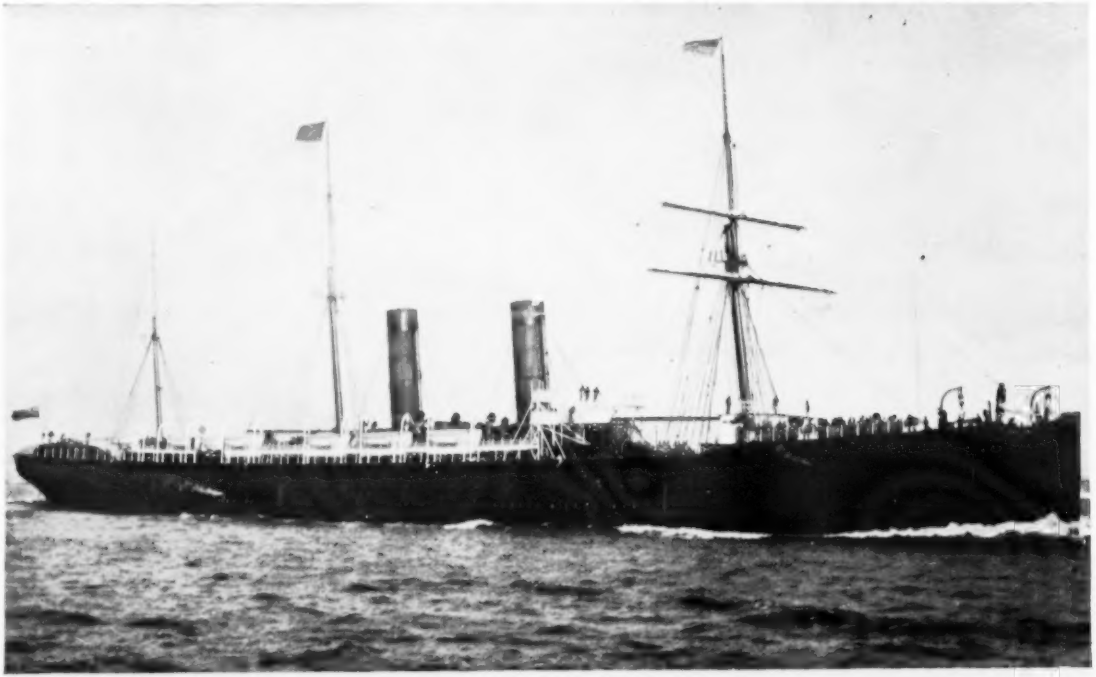
By Samuel Ward Stanton.

IN 1881 three notable steamships made their appearance almost simultaneously in the transatlantic trade between England and the United States. These vessels were the Servia, of the Cunard Line, built by Messrs. J. & G. Thomson, at Clydebank; the Alaska, of the Guion Line, constructed by the Fairfield Shipbuilding Company; and the City of Rome, of the Inman Line, from the Barrow Shipbuilding Company's yard. The Servia, a splendid vessel, was the first of the Cunard Line steamers to be built of steel, and the first great express transatlantic steamer constructed of this metal. The steel used was that manufactured by the Siemens-Martin process. The great power of the engines necessitated a very rigid hull and framework as compared with the older and less powered steamships. The weight of the Servia was 620 tons less than it would have been had iron been used in her construction. She was able to carry more in proportion to her size than could an iron boat of the same dimensions. In connection with this introduction of steel into the construction of transatlantic liners, it is interesting to know that the first steel-plated steamers were the stern-wheel boats Pelican and Banshee, built by Messrs. Henry Bessemer & Co., at Sheffield, England, in 1863, the steel used being made by the bessemer process; thirty two other steamers were constructed of this material by the same firm up to 1880. These vessels were paddle and screw steamers of the smaller class, none of which ran across the Atlantic. The advantages of steel in strength and lightness as compared with iron remained unappreciated for many years. It is said that in the Great Eastern the ratio of indicated horse power to the tonnage of the vessel was 1 to 14. In the Servia the horse power was greater than the tonnage. This ratio is on the increase, for, with the advent of the latest Cunarders, the Lucania and Campania, we find the tonnage 13,050 and the horse power 31,050. The Servia proved a swift craft, but did not equal the performances of the Alaska, which, soon after her appearance, earned for herself the title "Greyhound of the Atlantic." This latter vessel was not as large as the rival ships, but she carried higher steam pressure, which drove the most powerful engines in proportion to tonnage that any steamship had yet possessed. The indicated horse power to tons gross was 1.514 to 1. The Servia's was 1.393 to 1



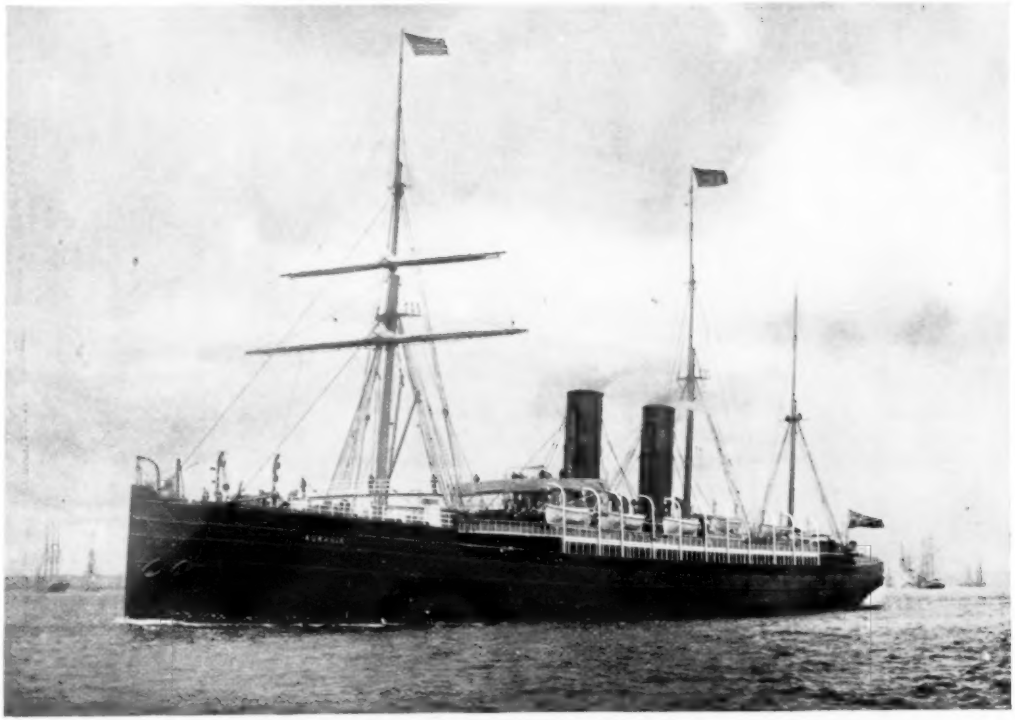
TRANSATLANTIC STEAMSHIP CITY OF ROME, OF THE ANCHOR LINE.

This steamer was the largest that had been constructed since the time of the Great Eastern up to 1881. Length 542½ feet; tonnage 8141.



STEAMSHIP SERVIA, CUNARD LINE, 1881.

First great transatlantic steamship built of steel. Length 515 feet; tonnage 7392; speed, 17 knots.

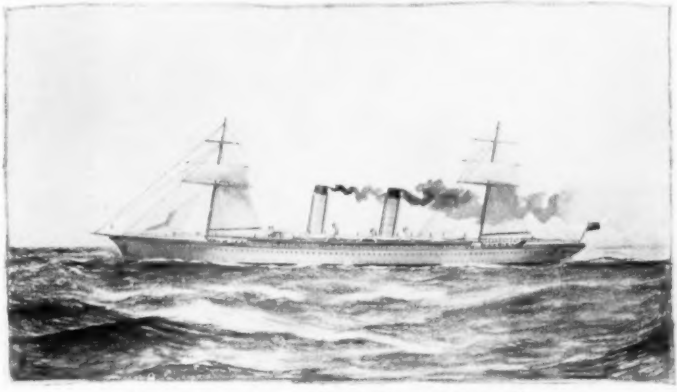


CUNARD LINE STEAMSHIP AURANIA, 1882.

Length 470 feet; tonnage 7269

RED STAR [AMERICAN] LINE STEAMSHIP WESTERNLAND, 1883.
Length 455 feet; tonnage 5736. One of a fleet running to Antwerp.

gross ton, while that of the giant City of Rome was 1.461 to 1. This latter vessel was of 8141 tons,—the largest that had been constructed since the time of the Great Eastern. She was built for the Inman Line, but, not coming up to their expectations regarding speed,—although she was a very fast vessel,—she went back into her builder's hands, who soon succeeded in disposing of her to the Anchor Line, which continues to run her, she being now its chief vessel. The Guion Line steamship Arizona had held the broom for fast passages, but her laurels were soon wrested from her by the new Alaska. This latter vessel made an average speed of 17¼ knots, while her best



STEAMSHIP AMERICA, OF THE NATIONAL LINE, 1884.
Length 432 feet; tonnage 6500. Speed 17.8 knots an hour.

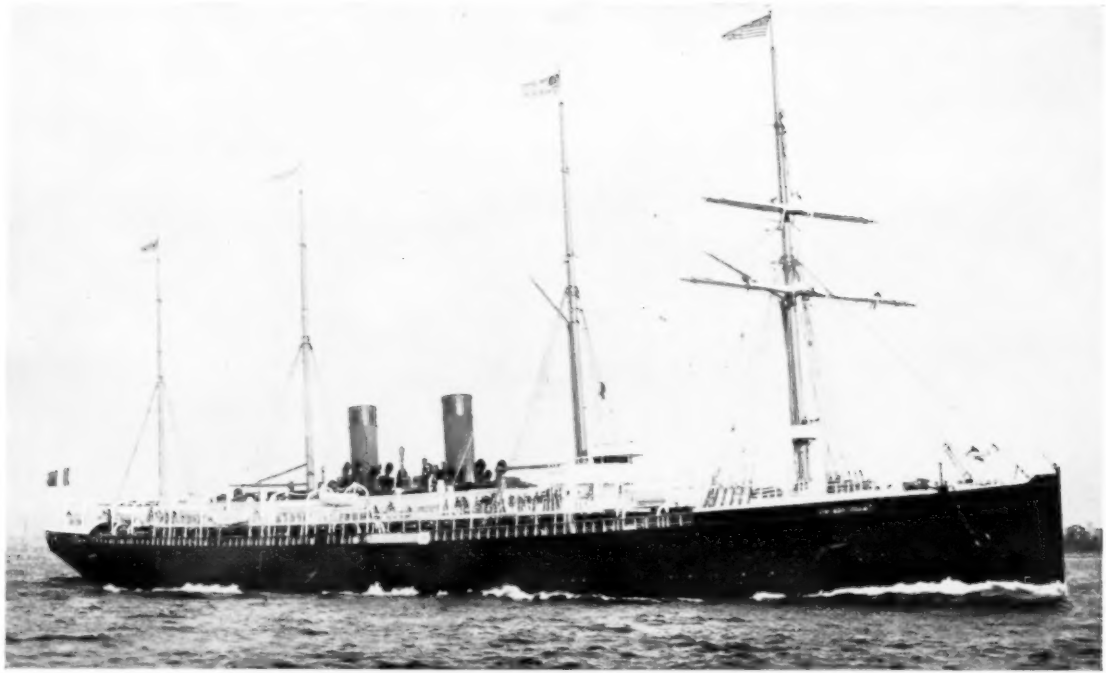
CUNARD LINE STEAMSHIP UMBRIA, BUILT 1884.

With her mate, the Etruria, held the record for fastest transatlantic passages for five years. Length 500 feet; tonnage 7718; 20.18 knots an hour.

day's run was 430 knots,—in October, 1883, going eastward. The Servia very nearly equalled this performance, having logged off 427 knots in one day during the same month. In May, 1888, the Etruria made 503 knots in one day, and since that the Paris has made 515 knots. The record at present is 560 knots, made by the Lucania.

Following the City of Rome, Alaska, and Servia, the next important liners that were put afloat were the Aurania, for the Cunard Line, the Oregon, for the Guion Line, and the America, for the National Line. This latter vessel was the smallest of the trio, but was possessed of a splendid model, her proportion of length to beam being 8.47 to 1, and her indicated horse power 1.131 to 1 gross ton. In the Aurania the proportion of length to beam was 8.24 to 1, while the indicated horse power was 1.169 per ton, as against the Oregon's 1.678 indicated horse power; the proportion of length to beam in the Oregon was 9.25 to 1. The indicated horse power of these steamers was as follows: Oregon, 12,382; Aurania, 8,500; America, 7,354. The Oregon made nearly 20 knots on her trial trip, and, soon after beginning her transatlantic voyages, made a day record of 440 knots; later this performance was eclipsed by the America, which made a record of 477 knots. While the Oregon held the record for the fastest passages, the America closely pressed her. The Oregon passed into the hands of the Cunard Line, by purchase, and was subsequently lost, while the America was bought by the Italian government for use as a cruiser. The building and running of the America was the only instance in the history of the National Line when that company had built a modern fast passenger steamer to compete with the better class of steamships in the trade in question; her consorts in the same line were not speedy or comfortable enough, however, as compared with the America and other modern boats, to enable the line to sustain the reputation which she brought to it, and so the company abandoned the plan of attempting to secure a share of the first-class travel.

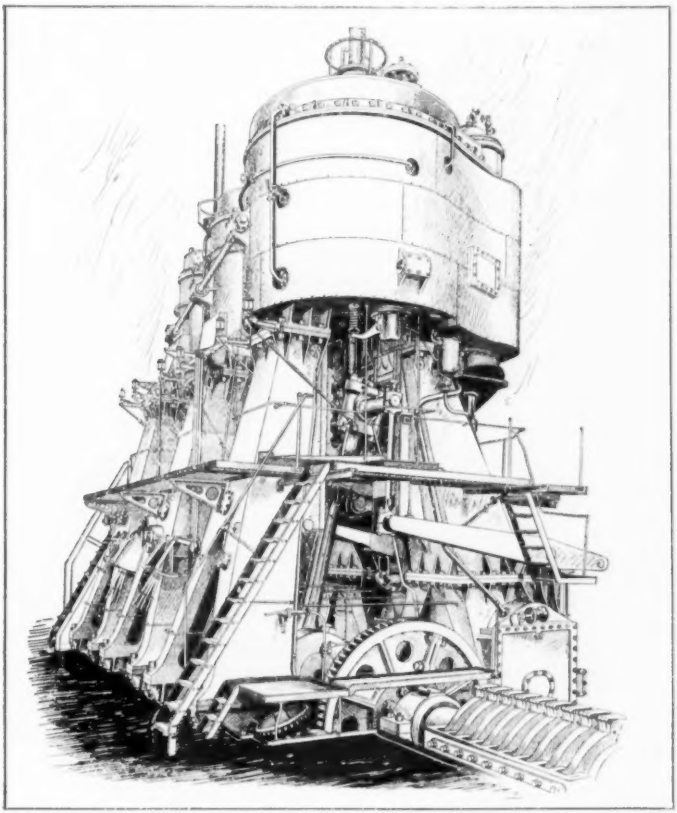
The Cunard Line regained its supremacy in the performances of the single screw steamers Umbria and Etruria, with compound engines, which, for 5 years, eclipsed the records of all other ocean steamships. During the first five years of their life their time of crossing the Atlantic was a little over 6 days. In the Umbria the proportion of length to breadth was 9.25 to 1, and in the Etruria it was 8.76 to 1, while the indicated horse power of each was about 14,321, or in the proportion of 1.85 to 1 gross ton. Their performances were very nearly the same. In 1888 the 503 knots covered in one day by the Etruria, while on her passage from England,—about 20.3 knots an hour,—was the fastest that had ever been attained at sea.



FRENCH LINE STEAMSHIP LA BRETAGNE, 1886.

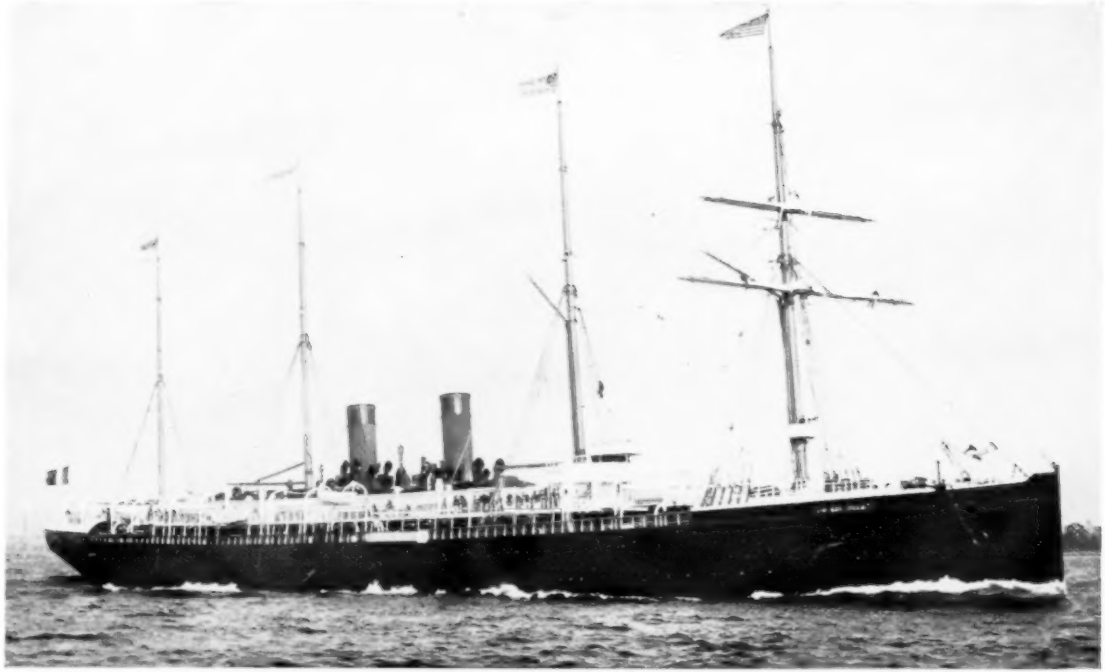
Length 495 feet; tonnage 7112; speed 17½ knots an hour.

Four important steamers appeared in 1889-90, immediately taking the leading place in the transatlantic trade. These were the City of New York and City of Paris (now New York and Paris), of the Inman Line, and the Majestic and Teutonic, of the White Star Line,—



ENGINE OF THE ALLER. FIRST TRIPLE-EXPANSION ENGINE USED ON A TRANSATLANTIC LINER, 1885.

all four vessels, in their trips across the ocean, bringing the record under 6 days. The City of Paris made 515 knots in one day in 1889, which was considered phenomenal. In the Paris we find that the proportion of length to beam is 8.37 to 1, while in the Teutonic it is 9.82 to 1.



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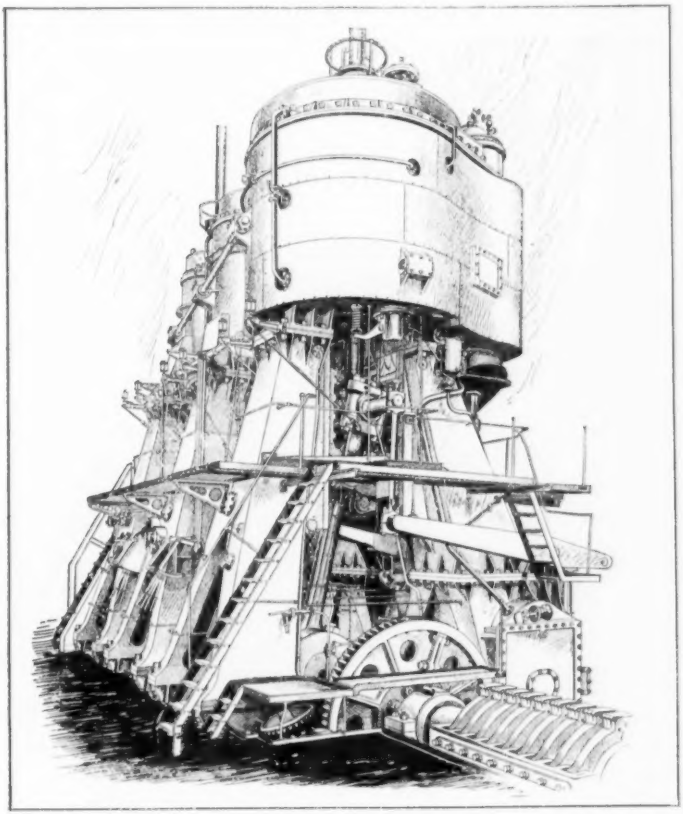

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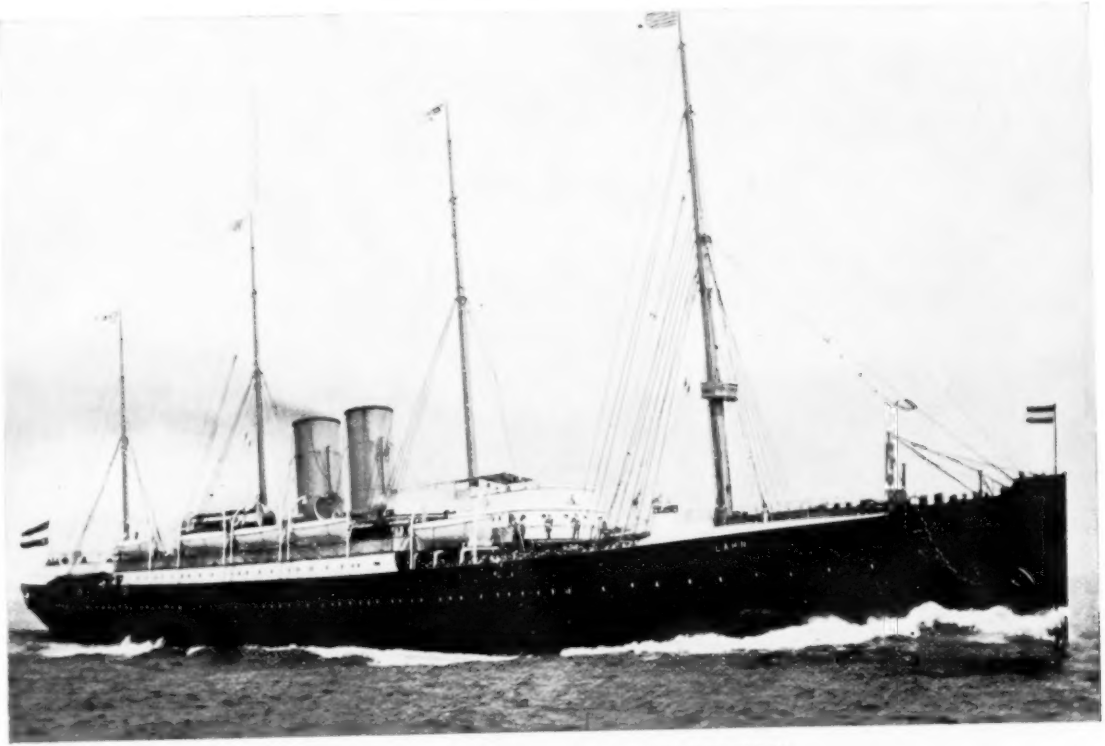
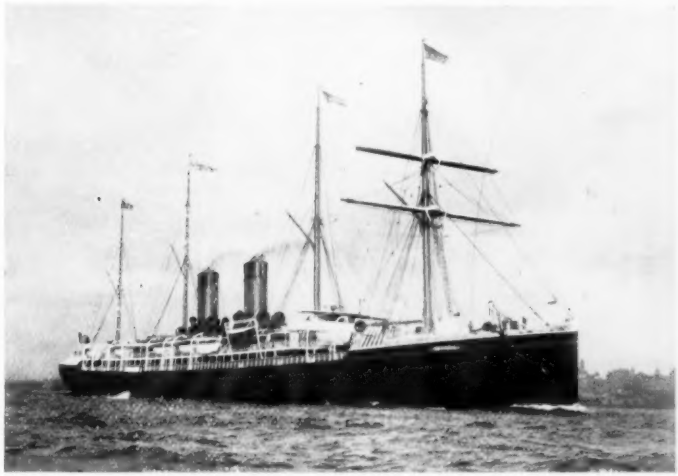


THE LAHN, OF THE NORTH GERMAN LLOYD STEAMSHIP CO.

Length 448 feet; tonnage 5661. The lost Elbe was similar to this vessel.

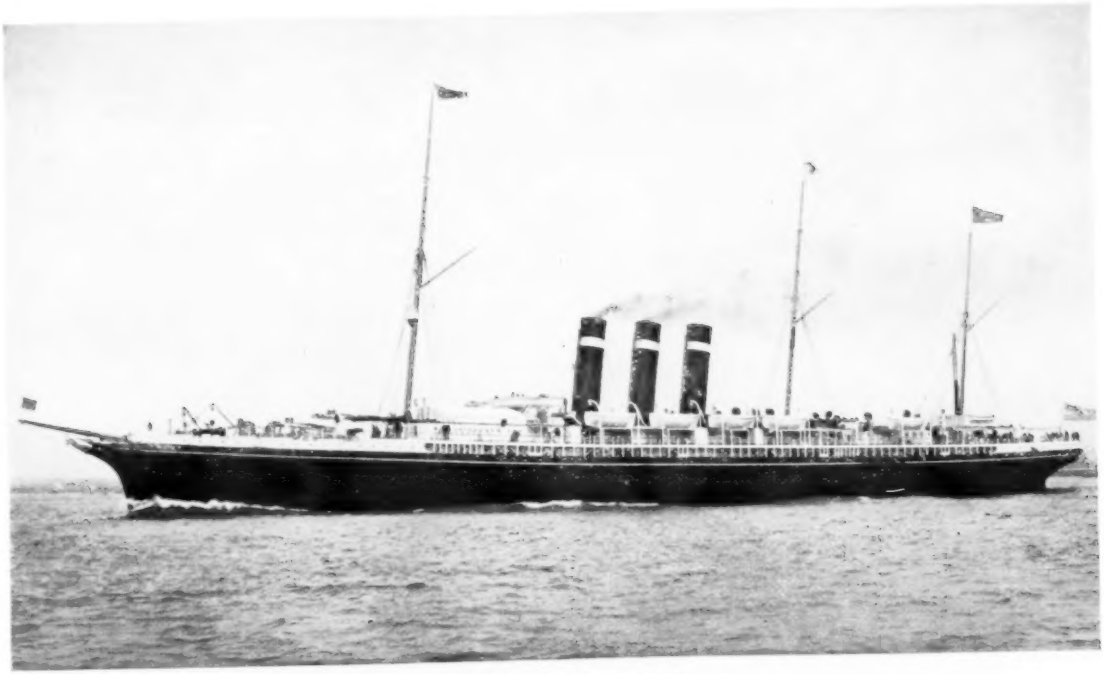
The keel of the Teutonic was laid in March, 1887, but it was not until August 7, 1889, that she left Liverpool on her first trip to New York. On this passage she crossed from Queenstown to New York in



STEAMSHIP LA BOURGOGNE, OF THE FRENCH LINE, 1886.
Length 491 feet; tonnage 7395; speed 17½ knots.

6 days, 14 hours, and 20 minutes,—at that time the quickest maiden voyage that any steamship had ever attained. The Majestic made her first trip across the Atlantic in April, 1890, reaching New York in 6 days, 10 hours, and 30 minutes. These two vessels have almost always maintained a speed of 19 to 20 knots in their passages across the Atlantic. It is claimed that either of them, should necessity arise, would be capable of steaming from Portsmouth to Bombay, *via* the Cape of Good Hope,—a distance of 10,730 nautical miles,—in 22 days, without coaling on the way.

To the North German Lloyd Steamship Company belongs the honor of using the first triple expansion engine in the transatlantic service. The vessel in which it was placed was the Aller, constructed by the Fairfield Shipbuilding Company in 1885. Two other vessels, similar in all particulars to the Aller,—the Trave and Saale,—followed, and were succeeded by the Lahn, the latter with a 5-cylinder triple-expansion engine. Contracts were then given to the Vulcan Works, at Stettin, resulting in the Spree and Havel, in which vessels we find evidence that the German shipbuilders are as thoroughly up-to-date as their English contemporaries. The Hamburg-American Line added



AMERICAN LINE STEAMSHIP PARIS.

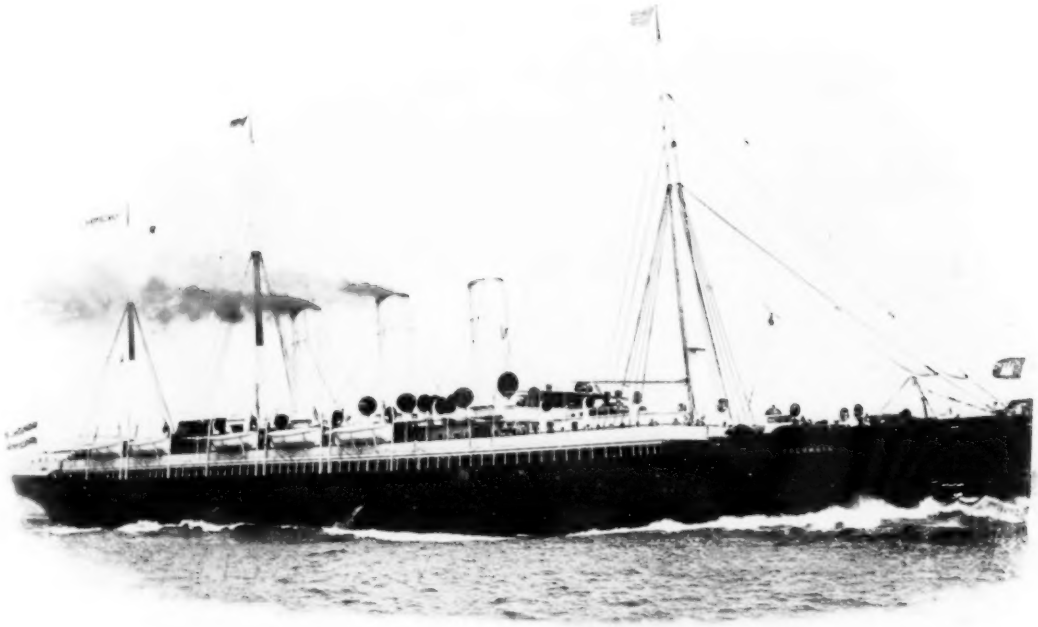
Length 577 feet; tonnage 10,499. One of the swiftest ocean vessels afloat. The New York is a companion ship.

to its fleet the fine steamers Columbia and Normannia, built in England, in 1889 and 1890, and the Augusta Victoria and Fürst Bismarck, built by the Vulcan Co., in 1889 and 1891, the two latter being magnificent triple-expansion engined ships. The Bismarck is able to steam nearly 21 knots an hour. The French have not been behindhand in the building of modern, high-class transatlantic steamers, as the Compagnie Generale Transatlantique's fine vessels testify, their latest steamer, La Touraine, with twin screws, being able to steam 19 knots an hour. Like the best of the steamships of her rival nations, the newer steamers of the French Line are held as naval reserve vssels by the government of that country.

The performances of the steamers of the rival lines being so much better than those of its own fleet, the Cunard Company contracted, in 1891, with the Fairfield Shipbuilding Company for two of the highest-

STEAMSHIP AUGUSTA-VICTORIA, OF THE HAMBURG-AMERICAN LINE.
Length 460 feet; tonnage 7661. Built in Germany.

powered transatlantic steamships that had ever been constructed, as well as the largest since the time of the Great Eastern. These two vessels were the Campania and Lucania, the greatest merchant



HAMBURG-AMERICAN LINE STEAMSHIP COLUMBIA.

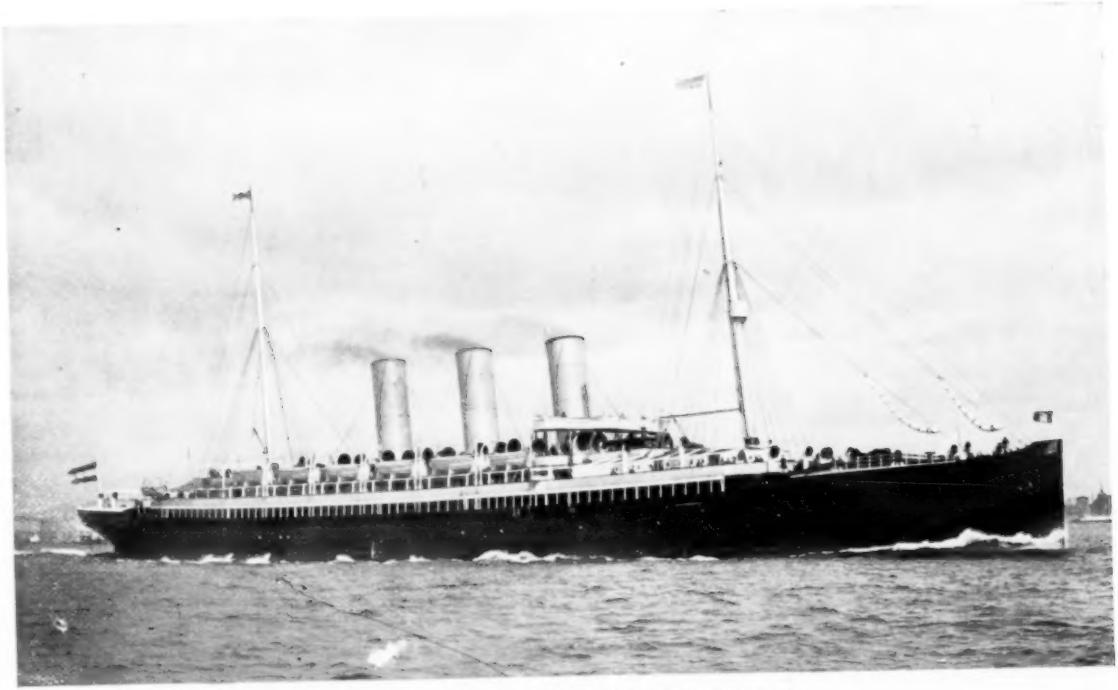
Length 462½ feet; tonnage 7578. Speed, over 19 knots an hour.

steamers afloat to-day, each of which, when ready to leave on her first voyage, represented an expenditure of nearly $4,000,000. With a tonnage of 13,050 and an indicated horse power of 31,050, these wonderful specimens of naval architecture embody the experience of nearly a century, and bear striking witness to man's ingenuity. They are constructed on the cellular principle, which admits of the use of water for ballast, and are the highest-grade steamers that England has ever produced. At the end of her first year's service the Campania had covered, in nine voyages, over 50,000 nautical miles, at an average of 20.304 knots, and the Lucania, in six voyages aggregating 33,500 miles, averaged 20.394 knots. This gave these giant steamers an advantage of 1¼ nautical miles per hour over the next best vessels in the Atlantic service,—*viz.*, the Majestic, Teutonic, New York, and Paris.

FASTEST PASSAGES OF TRANSATLANTIC STEAMERS BETWEEN NEW YORK AND QUEENSTOWN, 1882-1895.

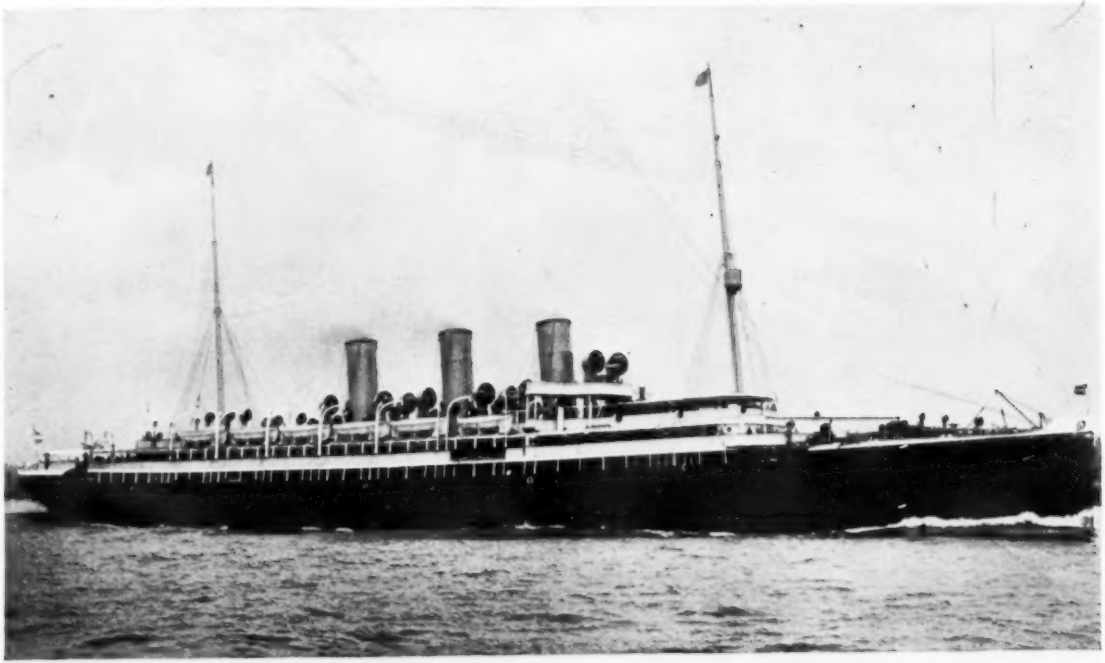
1882	Alaska, Guion Line, westward	7 days	6 hours	43 min.
1882	" " eastward	6 "	22 "	0 "
1884	Oregon, " westward	6 "	9 "	42 "
1884	America, National Line, eastward	6 "	14 "	8 "
1884	Oregon, Guion Line, eastward	6 "	11 "	9 "
1885	Etruria, Cunard Line, westward	6 "	5 "	31 "
1887	Umbria, " "	6 "	4 "	42 "
1887	Etruria, " eastward	6 "	4 "	36 "
1888	" " westward	6 "	1 "	55 "
1889	City of Paris, Inman Line, westward	5 "	19 "	18 "
1889	" " eastward	5 "	22 "	50 "
1891	Teutonic, White Star Line, westward	5 "	16 "	31 "
1891	" " " eastward	5 "	21 "	3 "
1892	City of Paris, Inman Line, westward	5 "	14 "	24 "
1893	Campania, Cunard Line, eastward	5 "	12 "	7 "
1894	" " westward	5 "	9 "	6 "
1894	Lucania, " eastward	5 "	8 "	38 "
1895	" " westward	5 "	7 "	23 "

It is not out of place to say that the American Line has really been the foremost transatlantic steamship line in the successful application of improvements to its steamers, and the history of the line forms a striking lesson in steamship progress. Originally starting as the Inman Line, in 1850, as we know, with screw steamers, when all other lines were building paddle vessels, these pioneer steamships were provided with special quarters for steerage passengers. Iron, too, was one of the improvements in the construction of hulls which this line introduced. Then came the early adoption of the compound engine, when its merits were as yet almost unknown, followed by the triple expansion of steam, as soon as its practicability was demonstrated. This line, too, introduced the incandescent light and the search light; and it adopted the twin screw for the propulsion of its steamers. Finally,



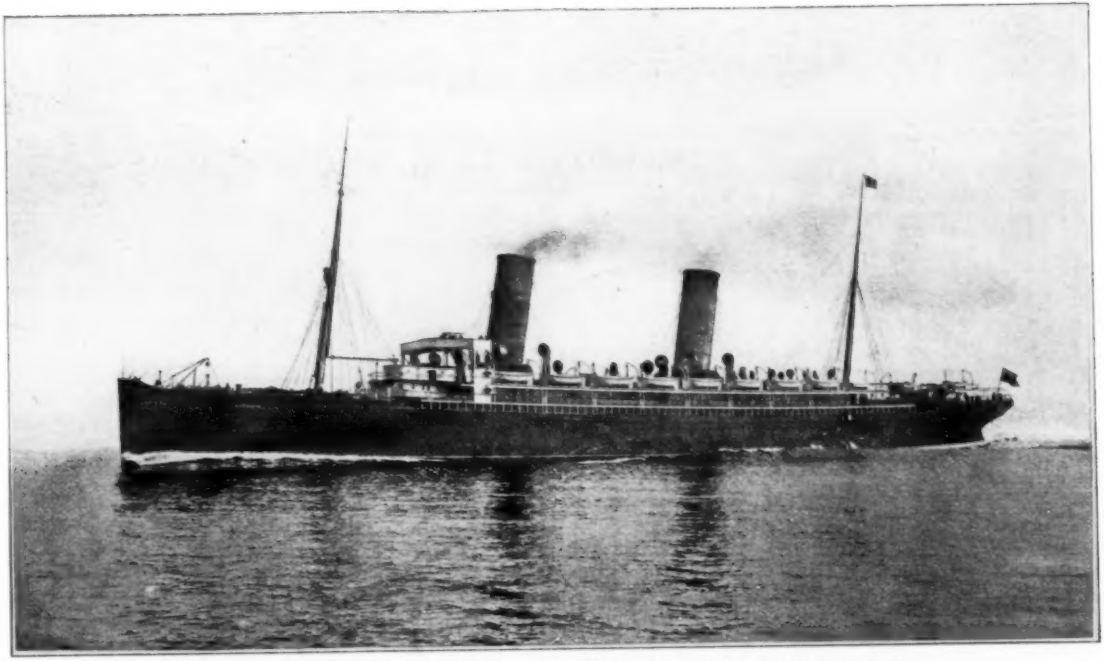
STEAMSHIP NORMANNIA, OF THE HAMBURG-AMERICAN LINE.

Length 500 feet; tonnage 8716; speed 20.78 knots an hour.



THE HAMBURG-AMERICAN LINE STEAMSHIP FURST BISMARCK.

Length 502½ feet; tonnage 8250; speed, over 20 knots an hour.



TRANSATLANTIC STEAMSHIP LUCANIA, OF THE CUNARD STEAMSHIP CO.'S ROYAL MAIL LINE.

This vessel and her mate, the Campania, are the largest ocean steamers ever constructed [the Great Eastern excepted], being the fastest and highest powered of any afloat. Length 600 feet; tonnage 12,050. The Lucania made, on her trial trip, 23.18 knots [nearly 27 miles] in one hour.

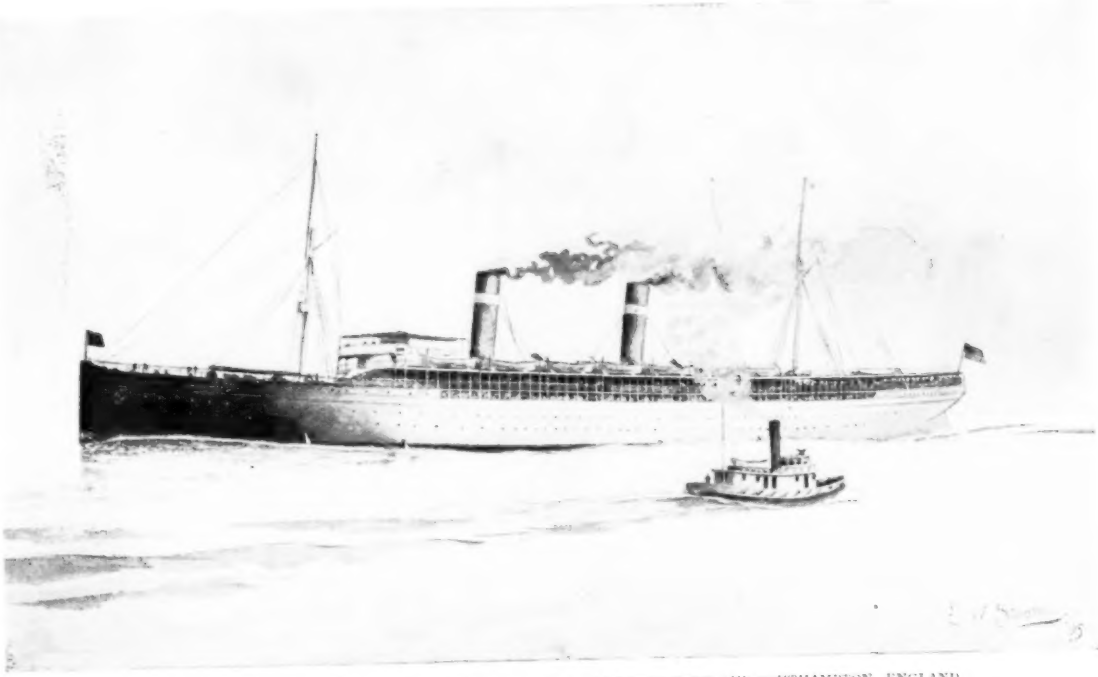
we find that the company's newest vessels, the St. Louis and St. Paul, are equipped with quadruple-expansion engines, the largest ever built and the first to be used in transatlantic steamers. These two vessels

TWIN SCREW STEAMSHIP MAJESTIC OF THE WHITE STAR LINE.

Length 566 feet; tonnage 9861. Has a mate in the Teutonic, both having a speed of 21 knots an hour.

constitute the most important advance in naval architecture ever made in the history of shipbuilding in the United States. They have been in service some time, and have proven themselves in every way fully up to the highest requirements of the service; and, while they have not attained the speed of the giant Cunarders (they have but ⅔ the power of these ships), they have numerous improvements over all others, and in some respects are in advance of the Lucania and Campania. The St. Louis and St. Paul were built by the Wm. Cramp & Sons' Ship and Engine Building Co., and are the largest steamers ever built in America. In designing them special attention was given to the question of safety, and their hulls are so subdivided by transverse bulkheads that, should two of them become damaged and the water enter and fill them, the ship would still float on in perfect safety. To support the outboard shaft bearings the hulls were built out in a horizontal web to a steel frame, having both bosses cast in one piece, and weighing about 28,000 lbs.

It is interesting to note that, with the completion of the St. Paul,



THE AMERICAN LINE STEAMSHIP ST. PAUL, PLYING BETWEEN NEW YORK AND SOUTHAMPTON, ENGLAND.

With her mate, the St. Louis, these vessels are in some respects the peers of any afloat, while their speed is only surpassed by their higher powered rivals of the Cunard Line. Each vessel is 534 feet in length, with a tonnage of 11,629. The indicated horse power is 20,000, giving a speed of 21.5 knots [nearly 25 miles an hour].

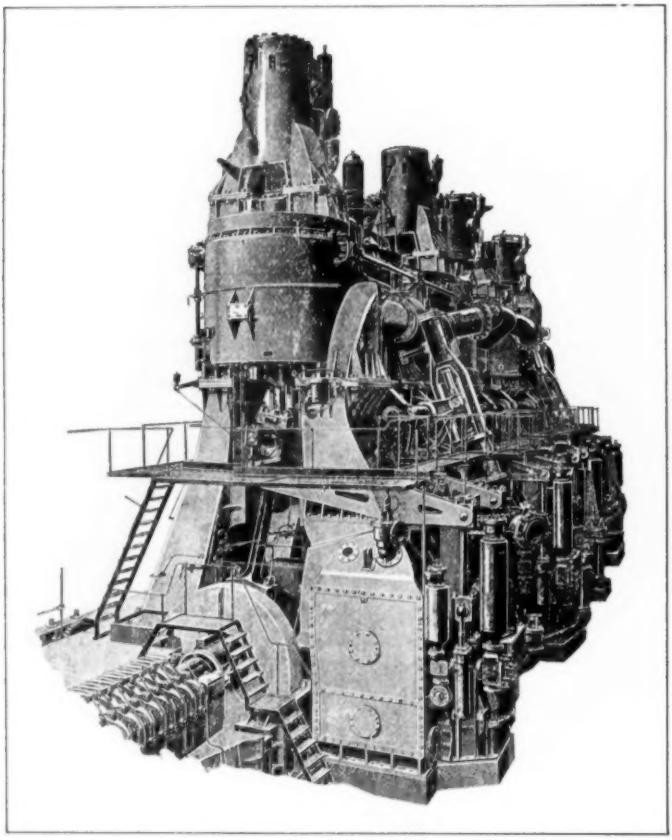
the United States government has at its disposal four magnificent steamships, which, in case of war, can be used as merchant cruisers. These are the New York, Paris, St. Louis, and St. Paul. They have been specially arranged so as to be readily and quickly convertible into armed cruisers, carrying 6-in. rapid fire guns, and with their great speed they would prove exceptionally fine naval vessels. For this privilege, we grant a weekly mail service, for which we pay $756,724 annually. A year ago the Cunard and White Star Lines received from the British post office department the sum of $527,500 for a semi-weekly mail service to this country, added to which the British admiralty gave $113,295, making a total of $640,795. In the same period the United States government paid to the Cunard Line $129,000, and to the White Star Line $47,176,—making the total paid by both countries $817,871. At the same time the United States paid to the American Line $188,720, to the North German Lloyd Line $157,764, and to the Hamburg American Line $45,311.

Five splendid twin screw steamships have recently been built for the Hamburg-American Line,—*viz.*, the Palatia, Patria, Persia, Prussia, and Phœnicia. The Persia and Prussia were the only vessels built outside of Germany, these two boats coming from the shipyard of Harland & Wolff, at Belfast, Ireland. The Hamburg-American Line has lately contracted with the shipbuilding firm of Harland & Wolff for the largest steamship since the Great Eastern, eclipsing in size even the Lucania and Campania, though not intended to steam more than 15 miles an hour. The principal dimensions are to be 560 ft. in length, 62-ft. beam, and 42 ft. in depth of hold, with a carrying capacity of 13,000 tons and a displacement of about 20,000 tons. While she is intended especially to carry a great cargo, she will have accommodations for 200 cabin and 1500 steerage passengers. There will be twin screws, driven by triple-expansion engines, and but one funnel.

COMPARISON BETWEEN THE BRITANNIA (1840) AND CAMPANIA (1895).

Britannia		Campania	
Length	207 ft.	Length	600 ft.
Breadth	34 ft. 3 in.	Breadth	65 ft.
Depth	22 ft. 5 in.	Depth	43 ft.
Tonnage	1,135	Tonnage	12,050
Indicated h. p.	740	Indicated h. p.	31,050
Cargo capacity	225	Cargo capacity	1,620
Speed per hour	8.5 knots	Speed per hour	23.18 knots
Crew	50	Crew	425
Fuel consumption per 24 hours	38 tons	Fuel consumption per 24 hours	450 tons
Hull of	Wood	Hull of	Steel
Style of engine	Paddle	Style of engine	Twin screws
Cost about	$100,000	Cost about	$3,550,000
Time of passage	15 days	Time of passage	5 days, 8 hours

When the City of Berlin came out in 1875, she was one of the fleetest of the transatlantic steamers, vieing with the Germanic and Britannic in the honor of holding the record. During late years this vessel has been running with new and improved engines of greater power, but her performance has not been noticeably bettered. The



TRIPLE-EXPANSION ENGINE OF THE LUCANIA.

One of the 5 cylinder engines of the Lucania and Campania [there are two in each ship], indicating over 15,000 horse power.

Germanic and Britannic, on the contrary, with new engines, have improved on their former records, and are faster boats now than they ever were. In fact, these two latter vessels are used in the express

service with the Teutonic and Majestic, and perform their trips with as much regularity and nearly as swiftly as their larger consorts. The Germanic, for instance, with her new triple-expansion engines, burns 30 tons of coal less per day, and her speed has increased a couple of knots an hour.

Between no other points on the globe has such an enormous trade sprung up as that existing at the present time between New York and the ports of Great Britain and Continental Europe. During 1894 879 passenger vessels arrived at the port of New York, bringing with them 92,561 cabin and 188,164 steerage passengers. While this showing is very good as to first-class passengers, there is a wide difference between the number of emigrants in 1894 and the 445,290 of 1891. Few people there are, comparatively, who realize the immense receipts and expenditures of a great transatlantic line. A steamship of any of the regular passenger lines to England, France, or Germany must earn from $50,000 to $100,000 per voyage to make a profit. The money that is made on the ocean nowadays comes from well-filled passenger lists, and therefore only lines owning and operating the largest and swiftest vessels can manage to pay dividends to stockholders. One famous line, the Guion, was forced to give up last year, and its steamers, the Arizona and Alaska, the queens of the ocean only 15 years ago, were laid up. Even in the cargo-carrying trade, nothing but the largest steamers, fitted with the most modern machinery and labor-saving appliances, are profitably worked.

It would seem that any company desirous of keeping to the front in the transatlantic passenger trade must still further increase the size and the power of its vessels, and, considering the mammoth proportions, immense power, and great cost of the present boats, which do not run with any great profit, it is a question whether the limit has not been reached. True, the North German Lloyd steamer will be larger than any now afloat, but she is not to be of great speed, nor will she consume in her running expenses the passenger and freight receipts of the voyage. That the ocean steamer of the present day is a safer, more comfortable, and vastly swifter boat than the vessels of a few years ago goes without question. The twin screw has undoubtedly worked wonders in regard, not only to speed, but to safety as well, one of the large liners, the St. Louis, having recently been steered into port by means of her propeller wheels, the rudder having become disabled. In 1890, while on the passage to England, the starboard engine of the City of Paris was completely wrecked by the breaking of the shaft, and the water, coming in, flooded the engine room, and, on account of the breaking at the same time of a portion of the bulkhead, the water also passed into an adjoining compartment. The vessel was

PROMINENT TRANSATLANTIC STEAMSHIPS, 1881-1895.

Year Built.	Name and Line.	Tonnage.	Trial Speed	Builders.	Length.	Breadth.	Depth.	Diameter of Cylinders and Stroke, in Inches.	Indicated horse power.
			knots		ft.	ft.	ft.		
1881	ALASKA, Guion Line	6932	18	Fairfield Shipbuilding Co.	500	50	39	One 68, two 100 × 72	10500
1881	SERVIA, Cunard Line	7392	17	J. & G. Thomson, Glasgow	515	52	40½	One 72, two 100 × 78	10300
1881	CITY OF ROME, Anchor Line	8141	18.23	Barrow Shipbuilding Co.	542½	52	39	Three 46, three 80 × 72	11000
1881	ELBE, North German Lloyd	4510	16.5	John Elder & Co. (Fairfield Co. Succes)	418	44	35		5600
1882	AURANIA, Cunard Line	7269	17.5	J. & G. Thomson	470	57	39	One 68, two 91 × 72	8500
1883	OREGON, Guion Line	7375	18.3	Fairfield Shipbuilding Co.	500	54	40	One 70, two 104 × 72	13300
1883	EIDER, N. German Lloyd	4719	17	" " "	420	47	34	One 62 & 86 × 60	7000
1883	WESTERNLAND, Red Star L.	5736	14	Laird Bros., Birkenhead	455	47	35	One 52 & 93 × 66	
1884	AMERICA, National Line	6500	17.8	J. & G. Thomson	432	51	38	One 63, two 91 × 66	7354
1884	[1]UMBRIA, Cunard Line	7718	20.18	Fairfield Co., Glasgow	500	57	40	One 71, two 105 × 72	14321
1885	ALLER, N. German Lloyd	5381	17.5	" " "	438	48	34	One 44, 70 & 108 × 71	8161
1886	[2]LA CHAMPAGNE, French L.	7087	17.5	Compagnie Générale Trasatlantique, St. Nazaire	493	51	33	One 90 & 41 × 67	9800
1886	[2]LA BOURGOGNE, " "	7395	17.5	Société des Forges et Chantiers de la Méditerranée, La Seyne	494	52	34	One 90 & 41 × 67	9800
1887	LAHN, N. German Lloyd	5661	17.78	Fairfield Co.	448	48	36½	Two 32½, one 65, two 85 × 72	8900
1888	[4]PARIS,* Inman (Am.) L.	10499	21.08	J. & G. Thomson	527½	63	41	Two 45, 71 & 113 × 60	20000
1889	AUGUSTA-VICTORIA,* Hamburg-American Line	7661	18.31	Vulcan Shipbuilding Co., Stettin	460	55½	39	" 41, 66 & 106 × 63	14110
1889	COLUMBIA,* Hamb. Am. L.	7578	19.15	Laird Brothers	462½	55	39	" 41, 66 & 101 × 66	13080
1890	[5]TEUTONIC,* White Star L.	9086	21	Harland & Wolff, Belfast	565	57½	42	" 43, 68 & 110 × 60	10500
1890	NORMANNIA,* Hamb.-Am.	8716	20.78	Fairfield Co.	500	57	38	" 40, 67 & 106 × 66	16352
1890	[6]SPREE,* N. German Lloyd	6963	19.6	Vulcan Co.	463	51	37½	" 38, 75 & 100 × 72	13000
1891	FURST BISMARCK,* H.-Am.	8250	20.7	" "	502½	57	38	" 43, 67 & 106¼ × 63	10412
1891	LA TOURAINE,* French L.	9209	19	Built at St. Nazaire	520	56	34	" 44, 60 & 100 × 65	13000
1893	[7]CAMPANIA,* Cunard Line	12050	23.18	Fairfield Co.	600	65	43	Four 37, two 79, four 98 × 69	31050
1895	[8]ST. LOUIS,* American L.	11629	22.5	Wm. Cramp & Sons, Ship and Engine Building Co.	534	63	42	Four 28½, two 55, six 77 × 60	20000

*Twin Screws. [1]Mate to Etruria, [2]Mate to La Bretagne, [3]Mate to La Gascogne, [4]Mate to New York, [5]Mate to Majestic, [6]Mate to Havel, [7]Mate to Lucania, [8]Mate to St. Paul.

near Queenstown at the time, and was towed into port, where the leak was stopped, and she proceeded to Liverpool under her own steam only a short time after. Such an accident happening to any of the old class of single screw boats would have undoubtedly proved fatal. It is only a question of time, it is said, when triple-screw express steamers will be put afloat; with the increased size and power of the transatlantic steamers, this seems to be the only way in which the present high grade of safety may be kept up. The steamships of to-day are as safe as they are swift, their designers having provided them with every requisite in case of danger. The steamship La Champagne, some years ago, was run into in the English channel, and several of her compartments were torn open and filled with water at once. In spite of this fact, she was able to reach port with comparative ease, and with no loss of life or inconvenience to her passengers. The use of water as ballast has grown greatly in favor with English designers, and has entered largely into the designing of their big steamers. Only with it, it seems, can British-built ships be rendered stable. Mr. Charles H. Cramp, the American shipbuilder, thinks differently, and with very good reason. He says: "Any system of design or construction which contemplates the carriage of water ballast (or other dead weight not cargo or coal) as an inseparable condition of stability under any circumstances is radically defective, and should be condemned. Of course every double-bottom ship should be so compartmented that the spaces may be used as trimming tanks for regulating fore and aft trim when desired, but I utterly reject and condemn any system under which they must be viewed as necessary adjuncts to stability. Under such a system no advantage can be taken of decreased draught caused by consumption of coal or absence of cargo, but the ship must always be kept down to a load draught in order to stand up. This is a purely English fad, and the English designers stick to it with characteristic tenacity." Mr. Cramp's superior judgment has been amply demonstrated, in that the performances of the St. Louis and St. Paul show them to be far stiffer and more stable, and that they roll less, than any ships in the transatlantic service. There are various improvements now in use on all first-class passenger and cargo steamships which have come to stay. One of these is the use of hydraulic power for the working of windlasses and other machinery, etc., on board a ship, such as the opening and closing of water-tight doors, the working of the doors of the boilers, etc. Steam steering-gear has proved an important adjunct in the equipment of a steamship, while forced draft and electricity for lighting and ventilating, and refrigerating machines for the keeping of perishable articles of food, etc., are hardly likely ever to be abandoned.

THE COST OF RAILROAD CONSTRUCTION.*

By John F. Wallace.

THE factors which determine the cost of railroad construction are varied, and are affected by local influences and time conditions. Railroads have been built across the prairies of the States lying between the Alleghany and Rocky mountains that did not involve a cash outlay, including equipment, exceeding $15,000 per mile. On the other hand, trunk lines have been built between important cities, some sections of which have cost as much as $100,000 per mile.

Railroad construction in the United States might properly be divided into three distinct classes, as follows:

First: trunk-line construction,—that is, construction of lines between prominent cities, with everything up to the standard of the American trunk line railroads. The average cost per mile of a line of this character at the present time would be approximately as follows:

Right of way	$ 2,000.00	Water supply, station buildings, round houses, etc.	$ 1,200.00
Bridges and culverts	4,000.00	Engineering	700.00
Graduation	12,000 00	General and legal expenses	600.00
Ballast	3,000.00	Proportion of terminals	5,000.00
Track material and laying	7,000.00	Equipment	4,000.00
Fencing	400.00		
Telegraph	250.00		
			$40,150.00

East of the Mississippi valley this estimate would be increased by additional cost under such items as right of way, bridges and culverts, graduation, etc. West of the Mississippi valley, in the mountainous country, the cost of bridges, culverts, and graduation would be increased in the construction of long trunk lines, and the cost of terminals would be diminished. This sample estimate, however, will fairly show the average cost of the ordinary trunk line in the central portion of the United States. To this amount should be added the cost of financiering, which is not usually taken into estimates of this kind; experience in railroad promotion has shown that new lines necessarily have to dispose of their securities at a discount, whereas interest has to be paid on the face value. A discount of 10, 15, or 20 per cent.

*It is proper to say that whereas the estimates of cost here given are necessarily approximate, they are, nevertheless, prepared from exact data as to the actual cost of railroad construction in various parts of the United States. In other words, Mr. Wallace is both a distinguished and a practical engineer, and for that reason his estimates may be accepted as a safe guide for both railroad officials and railroad investors.—THE EDITOR.

on the bonds of an enterprise of this kind is not unusual, which would increase the above cost to approximately $50,000 per mile.

Second: main lines of roads which do not form parts of through trunk lines, but which connect towns and cities of secondary importance, and upon which alignments and grades can be adopted that will admit of economical construction. A sample estimate of the average cost per mile of a line of this character, under present conditions, would be substantially as follows:

Right of way	$ 1,500.00	Fencing	$ 400.00
Proportion of terminals	1,500.00	Water supply, station buildings, round-houses, etc.	800.00
Bridges and culverts	2,500.00	Engineering	500.00
Graduation	6,000.00	General and legal expenses	400.00
Track material and laying	6,500.00	Equipment	2,500.00
Ballast	2,500.00		
Telegraph	250.00		
			$25,350.00

Third: branch lines,—that is, lines tributary to existing railroads, comparatively short, whose function is simply to bring passengers and freight to junction points with main lines, to do which two passenger trains and possibly three or four freight trains daily would fulfil maximum requirements; lines on which, also, heavier grades and sharper curves can be used, where desired, in order to lessen the cost of construction without materially increasing the cost of maintenance and operation. The average cost of a line of this character would be about as follows:

Right of way	$ 1,000.00	Water supply, station buildings, round-houses, etc.	$ 500.00
Proportion of terminals	500.00	Engineering	400.00
Bridges and culverts	1,500.00	General and legal expenses	200.00
Graduation	3,000.00	Equipment	1,500.00
Track material and laying	6,000.00		
Fencing	300.00		
Telegraph	200.00		
			$15,100.00

We may now consider the different items in detail.

Right of Way. The value of right of way depends, of course, on local conditions. For a single-track branch railroad, in a comparatively level country, from 50 to 66 ft. may be sufficient. On a low-grade trunk-line railroad, with high embankments and deep cuttings, with the probability that second and additional tracks will be needed later, from 100 to 200 ft. is generally required, and at important embankments and cuts still more. In the construction of lines across prairie country, where the building of the road will be of more or less local benefit, donations of right of way are frequently made, or the prices modified. Under ordinary circumstances, however, the average cost of right of way will be substantially double the usual local

market value of the real estate. But, when it is necessary to secure a right of way in a thickly-settled portion of the country already under cultivation and well supplied with railroads, and where the property is cut diagonally, it is frequently necessary to pay four or five times the ordinary local value of the real estate actually occupied by the right of way; and it is sometimes necessary to purchase more land than is actually required, in order to make satisfactory settlements. It is true that the right of condemnation can be and is frequently utilized, but this mode of obtaining possession restricts the use of the property to railroad purposes. The best railroad managers prefer a deed in fee simple.

Bridges and Culverts. The cost of bridges and culverts will of course depend upon the local physical conditions of the country the line traverses, and upon the character of construction which the engineer in charge may determine upon.

Graduation. This item also is entirely dependent upon local physical conditions; the cost may vary from $1000 or $2000 per mile in prairie country and on branch lines where low grades are not essential, to many thousands of dollars per mile for main line construction in rough country and where solid rock may be encountered.

Ballast. This item will vary from a few hundred dollars per mile for branch lines, where the ordinary soil of the country is frequently used for this purpose, to $1000 or $2000 per mile for gravel, according to the proximity of the gravel pits, and to $2000 or $3000 per mile for rock ballast, again according to the proximity of the quarries.

Fencing. This item is small and substantially uniform, regardless of the classification of the railroad, but is dependent upon local requirements, different States placing various interpretations upon the term legal fence.

Water supply, station buildings, round-houses, etc. This item, of course, varies largely with the classification of the road, the character of its business, and the ideas of the management as to what is proper and necessary.

Engineering. The cost of engineering, while comparatively a small item in itself, frequently affects the cost of the other items materially. The money appropriated for this purpose is supposed to be spent in securing the best obtainable talent, which is expected to determine the most economical means of accomplishing the purpose for which it is engaged,—*viz.*, the location and construction of a line of railroad which will be able to handle the greatest amount of business for the minimum of outlay, this outlay including, of course, interest on cost of construction, plus maintenance and operating charges. The cost

of engineering is influenced by the ideas of the management, as well as by the ideas, economical or otherwise, of the chief engineer.

General and Legal Expenses. These vary, according to the personal qualifications and business ability of the promoters, from a small amount per mile for branch lines to the large amounts necessary in securing the construction of a line through a well-settled country, and particularly terminal facilities in large towns and cities, and in settling the complications and litigations that arise in negotiating with other railroads for connections and crossings.

Terminals. This element of expense is affected greatly by local conditions in the city where the terminal is situated.

Equipment. The cost of equipment depends not only on the character of the line, but also on the volume of its business.

Having touched upon the variations in the cost of the different items of railroad construction, due to local circumstances, it is now proper to mention the variations in cost that are due to time conditions,—*i. e.*, the variations in the cost of different items from year to year, as the result of the general development of railroad construction.

Right of Way. The cost of right of way is continually increasing year by year, as the country becomes more settled and land in consequence rises in value, and as the feeling of the necessity for additional railroad facilities diminishes in the minds of the general public.

Bridges and Culverts. The cost of bridges and culverts is continually increasing, due to :

(*a*) The fact that rolling-stock and equipment are increasing in weight. During the past 25 years the average weight of locomotives and loaded cars has doubled, requiring bridges and culverts of proportionately stronger construction.

(*b*) The facts that the ideas of engineers and railroad managers are tending towards stronger and safer structures, and that a surplus of material is being used in iron and steel structures, particularly on shorter spans than were formerly considered requisite to safety.

Graduation. The cost per cu. yd. of this item has been gradually decreasing, on account of the improvements in the methods and machinery adopted for work of this character. On the other hand, the quantity of material considered necessary for railroad construction has increased. In the past 20 years the standard cross section for embankments has been enlarged from 14 ft. to 18 ft. in width at sub-grade ; excavations, from 20 ft. to 28 ft.

Ballast. The cost of ballasting, more than any other item, is affected by local conditions, but has not been materially changed.

Track. Under the head of track is considered the cost of ties, which has been steadily advancing year by year. The cost of grade

ties has been substantially doubled in the Mississippi valley in the past 30 years. This item is also affected by an increase in the quantity used, the number of ties to the mile having been increased on first-class roads from an average of 2640 to about 3000. As to rails, while it is true that there has been a steady and uniform decrease in the price of steel during the last quarter of a century, the average standard weight of rail for main lines has at the same time increased from 60 lbs. to 90 lbs. per yd., and the quality has materially depreciated. As an example of the deterioration that has taken place in quality, the writer may state that during the past year he has relieved from a main track on tangents rails that weighed 75 lbs. to the yd. which had been in the track only 5 years; whereas, on the same district and under precisely the same traffic conditions, there still remain in the track 60-lb. rails that have been in service for over 15 years, which it was not considered necessary to renew this season. While this may be an exceptional case, the writer considers the steel rail which was furnished by the manufacturers 15 to 20 years ago about 50 per cent. better than the rail now manufactured. This is not intended to apply to special high-class rails, which may be furnished by a few rolling mills under superior specifications, but to the ordinary rail supplied to and purchased by the majority of the railroads in the United States to-day. The reason of this inferiority hardly comes within the scope of this article.

Fencing and Telegraph. These items have remained practically unchanged during the last few years.

Water supply. As business has developed on the railroads, a larger and more constant water supply has become necessary, and tanks, wells, and reservoirs are now being constructed of much larger capacity than ever before. The capacity of tanks and pumping machinery has been practically doubled.

Station buildings. The increase in the cost of station buildings is not due to an increase in the price of material, but to the growing necessity for better accommodations for the travelling public arising out of a natural increase in business.

Round-houses and other structures. The cost of round-houses is substantially the same, except for an increase due to the demand for additional facilities, improved smoke-stacks, more expensive engine pits, turn-tables, etc.

Engineering. The cost of this item has been substantially the same during the past 20 years.

General and legal expenses. These have greatly increased in late years, due to the many new complications that are constantly developing in railroad construction, as population and railroads increase.

Terminals. The expense of railroad terminals is rapidly increas-

ing year by year, because of the growing density of population in cities and the fact that the earlier railroads occupy the most advantageous positions.

Equipment. The cost of equipment is practically the same as it was a quarter of a century ago. While engines have been increased in size and weight, cars in strength and capacity, and coaches and sleepers in elegance and accommodation, a corresponding decrease has taken place in the price of the material and machinery used in their construction. There has also been a fierce competition between large corporations engaged in the manufacture of different articles of railroad equipment, which has had an influence in lowering prices.

In the foregoing estimates and remarks two items of considerable importance have been mentioned, which we may consider further.

The cost of railroad construction has been materially increased of late by the necessity of providing crossings for the new lines over existing roads. In the earlier years of railroad construction, if the junior road would agree to put in the crossing frogs and maintain them, the senior road was satisfied. Now the senior road frequently requires the junior road to construct its line over or under the existing road. The expense of a crossing of this character varies from $10,000 to $100,000, according to local conditions. Even if an over- or under crossing is not insisted upon, expensive interlocking plants are required, which entail additional burdens on the new road, not only in the first cost of construction, but in operation and maintenance as well.

The most important item of cost in railroad construction, however, is that of terminal expenses in the larger cities. This expense has now become so great in the leading cities that new roads usually prefer to rent their terminal facilities from existing lines. In Chicago to-day there are roads paying a rental for terminal facilities—and restricted terminal facilities at that—equal to the interest on $10,000,000. In order to emphasize the importance of this item, the writer will assert that, if a new line of railroad were built from Kansas City to Chicago by way of St. Louis, with adequate independent terminal facilities in these three cities, the cost of the terminals would be in excess of the cost of the remainder of the road, fully equipped.

The total cost of railroad construction is continually increasing year by year. While some items may have been cheapened on account of the lower price of material or labor, or by competition, other items are increasing in much larger proportion; and the public requirements of safety, speed, and convenience are steadily adding items of cost which in former years were not considered necessary,—among them, superior character of the road-bed, block and interlocking signals, air brakes, patent couplers, special cars for high-class products, etc.

SCHOOLS AND SCHOOL-HOUSE ARCHITECTURE.

By E. C. Gardner.

THE earth rests upon an elephant, and the elephant stands upon a tortoise: that is a fable. Our own country rests upon public schools; upon universal homogeneous, free, public education: that is fact.

Since the first requisite of good architecture is adaptation of means to end, the use and importance of public school-houses must be fully appreciated before they can be wisely planned. Especially is it incumbent on those who are responsible for the buildings—not architects, but city governments and their commissions, superintendents, and school boards—to have a clear perception of whatit means to build a school-house. These buildings are not luxuries, but necessities; they should not be postponed till indispensable, but the supply should precede and stimulate the demand; instead of the time being near at hand when we shall have enough for present and future need, we are but just laying the foundations. To increase the terror of the unwilling tax-payer, it may be affirmed that, of the school-houses built 25 years ago, not to mention many of more recent date, a large portion are so illy adapted to their use, so poorly lighted, so badly ventilated and plumbed, so imperfectly heated, so unfavorably located, in a word, so unsanitary in some one or more important particulars, that their destruction would be an actual benefit, provided, of course, they were replaced by something better.

"It is my opinion," said the principal of the largest public school in one of our great American cities, "that all our school houses should be built with the distinct understanding that they are to be destroyed at the end of 20 years,—25 at the farthest. Our old buildings, stand stubbornly in the way of changes that must come sooner or later, many of which would come at once, if it were not found expedient and economical to adapt the school to the house rather than the house to the school."

That is perhaps one extreme. The other was expressed in a recent address before a teachers' convention in the Connecticut valley, in which the president of one of the eastern colleges urged that "every school-house should be a veritable palace."

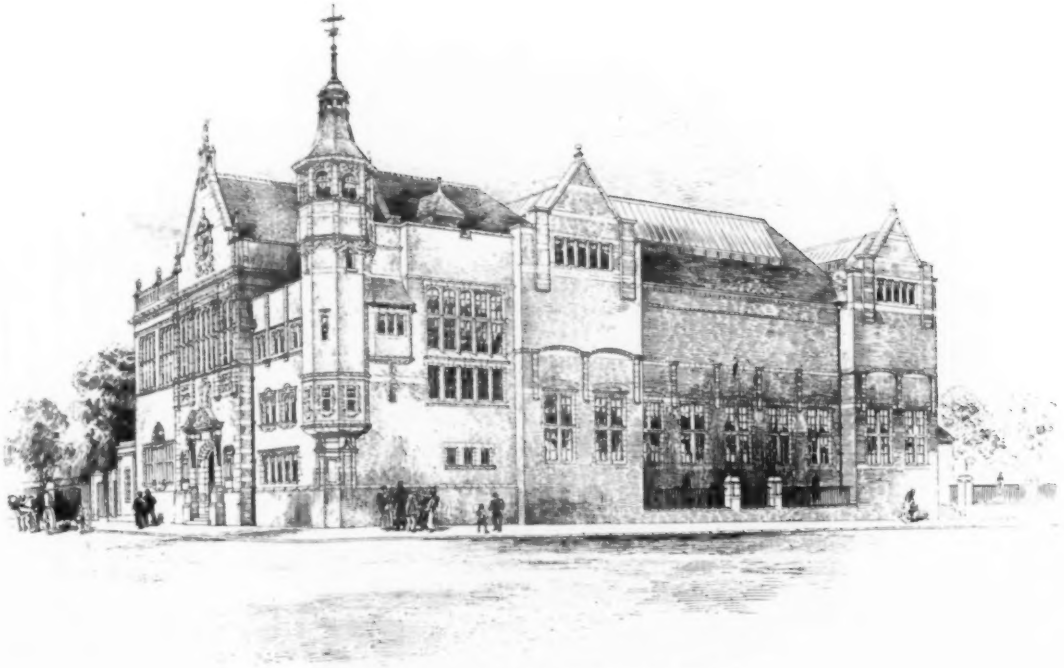
The average citizen would hardly vote for the destruction of a palace, and, if we build palaces, we must be prepared to keep them;

although, for the better education of the children, the occasional spoiling of a palace would be less foolish and wasteful than many of the follies committed by municipal authorities in the way of public architecture.

If the safety, health, and highest good of the children are best achieved by means of palaces, let us have palaces; but, before crip-

BERKELEY SCHOOL, FORTY-FOURTH ST., NEW YORK.
Lamb and Rich, Architects.

pling our resources for years to come in order to erect a palatial building, largely by way of monument to the administration that "carries it through," it is well to be sure that its conservative magnificence will not prove a stumbling-block to its usefulness. The readiest compromise would be to see that every large school-house, whether palatial or otherwise, shall have a site large enough for indefinite modification and growth. For, once occupied, a poor site is an incurable evil, whether its fault is of size or environment. Even a low, damp situation is not so objectionable as a lot too small or shut in by unfa-



THE VICTORIA INSTITUTE, WORCESTER, ENGLAND.

J. W. Simpson and E. J. Milner Allen, Architects.

vorable surroundings, for it may be drained and converted into salubrious, solid ground.

When plans for a school-house are unfavorably modified to suit a limited site,—and this occurs more frequently than I would dare to intimate,—the building is permanently damaged, and, before building, the question should be asked and unflinchingly answered: "Would the proposed plan be adopted, if the lot on which it stands could be enrlaged at will?" Something is positively wrong, if this must be answered negatively.

There are various matters relating to the general organization of

SCHOOL-HOUSE, FIFTY-EIGHTH ST. AND MADISON AVE., NEW YORK.
C. B. J. Snyder, Architect.

schools which also concern the plan and about which the doctors differ.

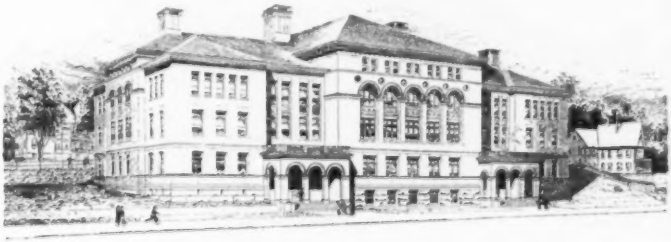
"What is the largest number of pupils that may be placed in one high school without disadvantage?" was one of several questions addressed to about fifty prominent educators in the United States from New England to California. Seventy-five per cent. of the replies suggested from 800 to 1000; 20 per cent. would limit the number to 600; and the remainder would not fix a limit, accepting several thousands, if properly managed. Another question was whether, in case

STATE NORMAL SCHOOL, JAMAICA, NEW YORK.
Cram, Wentworth, and Goodhue, Architects.

ENGLISH HIGH SCHOOL, CAMBRIDGE, MASS.
Chamberlin & Austin, Architects.

of a school of 800 or more, the preference would be for one large sitting or study room for the entire school, with numerous recitation rooms; for two such rooms; or for a sufficient number of small sitting rooms, in which the teacher could conduct her own classes. More than 75 per cent. distinctly preferred the separate class rooms to hold not more than 50 pupils each, a few limiting the number to 35 or 40, with a similar number of smaller rooms for recitations; and the remainder suggested different arrangements, no two being alike.

Other inquiries relating to the situation of the assembly hall, if there is one, to the chemical laboratories, and to heating and ventilation, brought still more varying replies. In certain parts of the country the separation of the sexes in at least some of the grades is preferred, and some would restrict the height of the buildings to one story above the basement.



HIGH SCHOOL, FITCHBURG, MASS.
H. M. Francis, Architect.

PRIMARY SCHOOL HOUSE, JAMAICA PLAIN, BOSTON, MASS.
Edmund M. Wheelwright, City Architect.

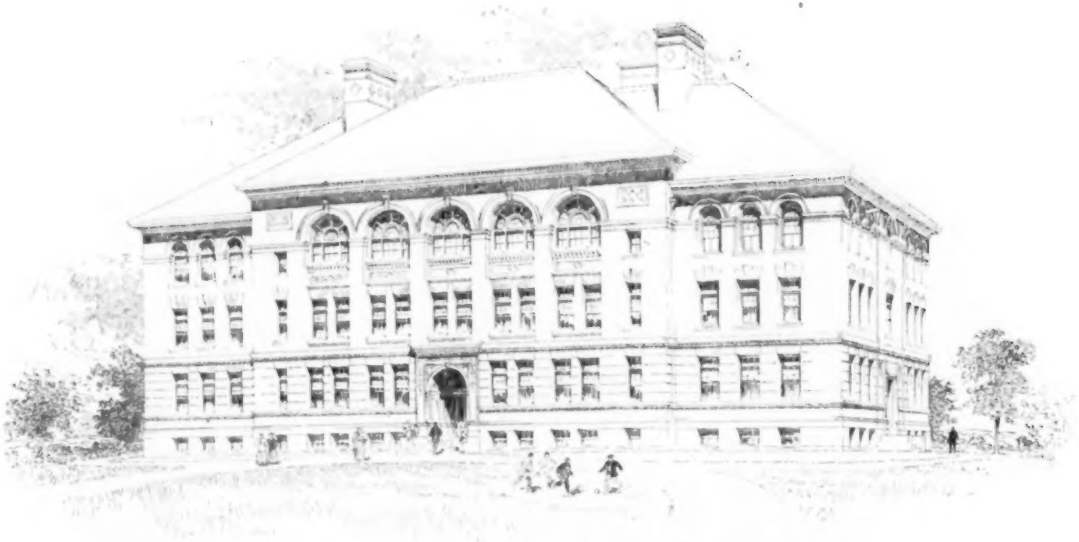
All these elements relate to the general plan. In minor matters there is a like variety of opinions. That the principal light for the class rooms shall be from the left of the pupils is admitted, but whether that shall be the only light is a point on which good authorities differ, although it is not maintained now, as it was in some countries a few years ago, that windows must be restricted to one side. In fact, unilateral lighting is now prohibited in some parts of Europe. Common sense would decide the matter quickly enough, if it were a question of light in a factory or business office. A long and narrow room may

AUSTIN PRIMARY SCHOOL, DECATUR ST., E. BOSTON, MASS.
Edmund M. Wheelwright, City Architect.

ROBERT GOULD SHAW GRAMMAR SCHOOL, WEST ROXBURY, MASS.
Edmund M. Wheelwright, City Architect.

be well lighted by windows in one of the long sides, but it would be impossible to light a square room of the same area by light at one side, unless its height is greatly increased,—still less an oblong room by windows in one end. Whether the external beauty of the building will be marred by placing the windows in the most advantageous situation for the interior will depend upon the skill of the architect. But there would still remain the alternative between disfiguring the building and injuring the eyes of the children.

AGASSIZ GRAMMAR SCHOOL, JAMAICA PLAIN, BOSTON, MASS.
Edmund M. Wheelwright, City Architect.



HIGH SCHOOL, SOMERVILLE, MASS.

Hartwell, Richardson, and Driver, Architects.

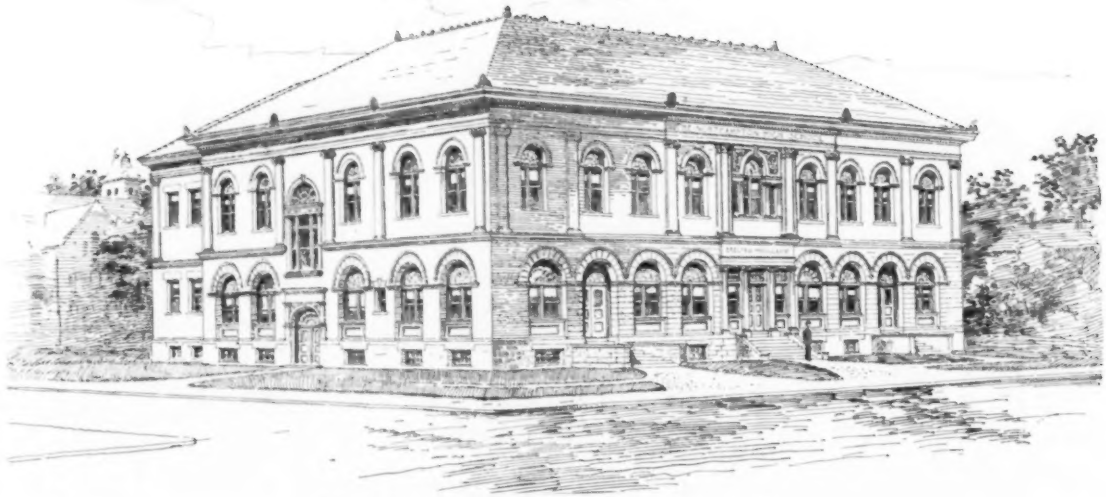
The proper height of the average class room is debatable; but this also calls for common sense. If lighted from one side only, the wider the room, the higher it should be. Speaking generally, the height should be equal to half the distance of the windows from the opposite wall, if there is to be good light upon the blackboards and the row of desks farthest from the windows.

The coat rooms are subjects for controversy. A separate room for each sex adjacent to each class room and communicating with it is a favorite demand; large frames 6 or 7 ft. high and of various lengths, set 3 or 4 ft. apart on the floor, carrying hooks for hats and outer wraps, with shelves or boxes for overshoes, the whole resembling cattle stalls or sheep racks, are often placed in the halls, vestibules, and corridors, which are enlarged to accommodate them. Similar screens placed near the entrances to each class room and forming what might be called wardrobe vestibules between the corridors and the class rooms

LABORATORY AND GYMNASIUM, THAYER ACADEMY, S. BRAINTREE, MASS.
Hartwell and Richardson, Architects.

are approved in Boston; while sentry boxes, with flexible doors to be closed when the boxes are full, and which may be placed in any desired location like Saratoga trunks or rolltop desks on end, are supposed to be capable of bottling up the effluvia from damp clothing until it can be removed through ventilating flues.

Another mooted point is the proper location of the toilet rooms. There are those of long experience and good judgment who would put in the basement all except those for the exclusive use of teachers. Others, equally wise and good, would have them in a separate wing, connected by open corridors to the main building. Still others would make provision for each sex on each floor; and many of no less common sense and discrimination would distribute them through the building, in the ratio of perhaps two groups on each floor for every hundred pupils.



THE NORTHAMPTON HIGH SCHOOL, NORTHAMPTON, MASS.

Gardner, Pyne, and Gardner, Architects.

Varying conditions might make one or another of these methods preferable in a given case; in the main they are questions of opinion, and should be determined by those whose wishes are to be regarded.

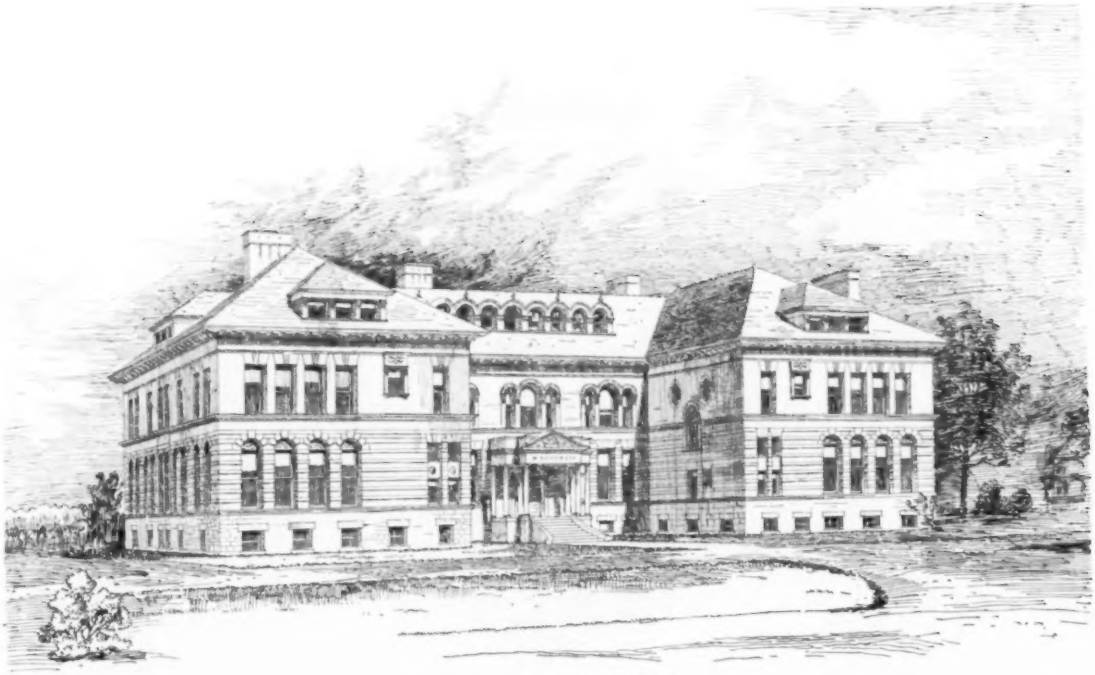
Then come matters of course. Certainly the coat rooms must be light, dry, warm, and well ventilated, and so arranged that each pupil can take his own without disturbing the rest. It is not necessary that he should be able to take a flying leap from the class room to the outer door, catching his hat as he flies. There is no serious objection to his crossing a corridor, or even the width of the building, if by this means better order can be maintained. In arranging corridors and passages, it should be borne in mind that mere distance is of slight consequence in comparison with conflicting routes in passing to and

THE WARD FOUR SCHOOL HOUSE, SPRINGFIELD, MASS.
Gardner, Pyne, and Gardner, Architects.

from recitation rooms. Corridors should have ample light and should be well ventilated, but it is not necessary in cold weather to keep them as warm as the class rooms.

Stairs should be wide, and of gradual ascent. It may be true that most children climb stairs with the same apparent ease that squirrels climb trees, but this is not true of all; and, to avoid the danger of falling, either with or without the impetus of a panic, the grade should not exceed 22½ degrees.

In all class and recitation rooms, at the teacher's end of the room and on the side opposite to the principal windows, all the available wall space to the height of 6 or 7 ft. should be covered with blackboards, preferably of natural slate.



DESIGN FOR A NORMAL SCHOOL.

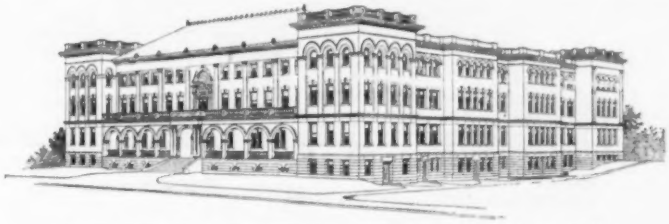
Gardner, Pyne, and Gardner, Architects.

A.—DESIGN FOR A HIGH SCHOOL. AN ALTERNATIVE FOR "B."
Gardner, Pyne, and Gardner, Architects.

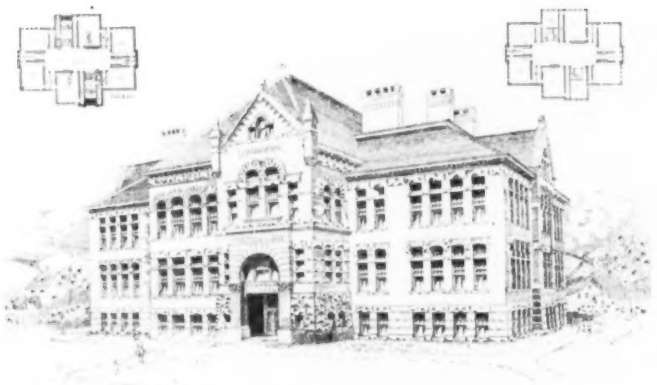
The windows should extend from about 3 ft. above the floor to within 6 or 8 in. of the ceiling. They should not have semi-circular tops or heavy wood or stone transom bars. They should be furnished with double shades, one set to be drawn up from the bottom, the other to be pulled down from the top.

Floors should be of hard wood so well seasoned that there will never be any visible cracks in them, and the upper floor should be thick enough to hold securely the screws that confine the desks and chairs,—no trifling matter, for the growing length and strength of boys are not easily restrained.

If wood wainscot is used on the walls where there are no blackboards, it should be entirely plain. With suitable backing a hard



B.—DESIGN FOR A HIGH SCHOOL. SAME GROUND PLAN AS "A."
Gardner, Pyne, and Gardner, Architects.



JACKSON SCHOOL, SALT LAKE CITY, UTAH.
Ware and Cornell, Architects.

cement wall, thoroughly painted, is cleaner and more durable than wood. Instead of the common plastering of lime and sand, some one of the many good cements should be used for all the plastered walls and ceilings, and all the corners and angles should be rounded.

Not the wainscot alone, but all the wood finish should be of the simplest style: if it can be dispensed with wholly, all the better. Whether considered from the esthetic or the sanitary point of view, harmoniously-tinted walls with plain painted pine finish are infinitely preferable to the most pretentious oak "trimming" on glaring white walls.

DAY SCHOOL BUILDING, SEATTLE, WASH.
J. Parkinson, Architect.

It is possible to use wood in really artistic forms; but the inevitable compromise between economy and art is, like most compromises, a failure both ways. Examples of real architectural and decorative art may be had even in the humblest school-house, but elaborate moldings and abortive carvings are not artistic, are not necessary, and for sanitary reasons are distinctly objectionable. Upon that ground their omission is perhaps as important as the abolition of slates, slate pencils, and sponges; the restriction of each pupil to the use of his own box of pens and lead pencils; the frequent changing of the paper covers of books that are used in common; the use of individual drinking cups; and the prompt disinfecting of rooms in which any pupil has been sick of contagious disease.

THE BRYN MAWR SCHOOL HOUSE, BALTIMORE, MD.
Henry Rutgers Marshall, Architect.

In the sanitary category stands also the providing of simple, healthful, and attractive-looking lunches, with the corollary that eating anything else, or at any other than the regular time, is prohibited.

Keeping still to sanitary matters, heating and ventilation by methods in common use are intimately related. Warm fresh air is easily introduced. I am not aware that warm foul air can be expelled

from a room without the loss of the heat that it carries. Undoubtedly it ought to be. There is an amazing waste when air that is brought into a room fresh and warm, at the rate of 30 cu. ft. a minute for each of the occupants, is immediately driven out at the same rate and at

ENDION SCHOOL BUILDING, DULUTH, MINN.
Traphagan and Fitzpatrick, Architects.

a temperature only 2 or 3 degrees colder than when it was introduced. If this same method were adopted in all the buildings of large cities, our winters would be the warm season, or all the coal beds would be exhausted. As warmth is none the worse for being used, it would seem to be good thrift to keep the good heat and expel the bad air. What electricity may do in this direction remains to be seen; it is not inconceivable that 10 years hence our present wasteful and complicated modes of heating and ventilation will seem as antiquated and unscientific as the famous method of preparing roast pig.

Accepting the present manner of forcing warm fresh air into each room as the best attainable, there are still a right and a wrong way of doing it. As the warm air is sure to rise, or, rather, to be lifted to the top of the room, it may as well enter near the ceiling; the incoming current will not be felt, and, if the exhaust is at the same side of the room near the floor, the entire atmospheric contents will be brought to a uniform temperature, and will be constantly changed. It is sometimes urged that the warm air should be driven into the rooms at the sides

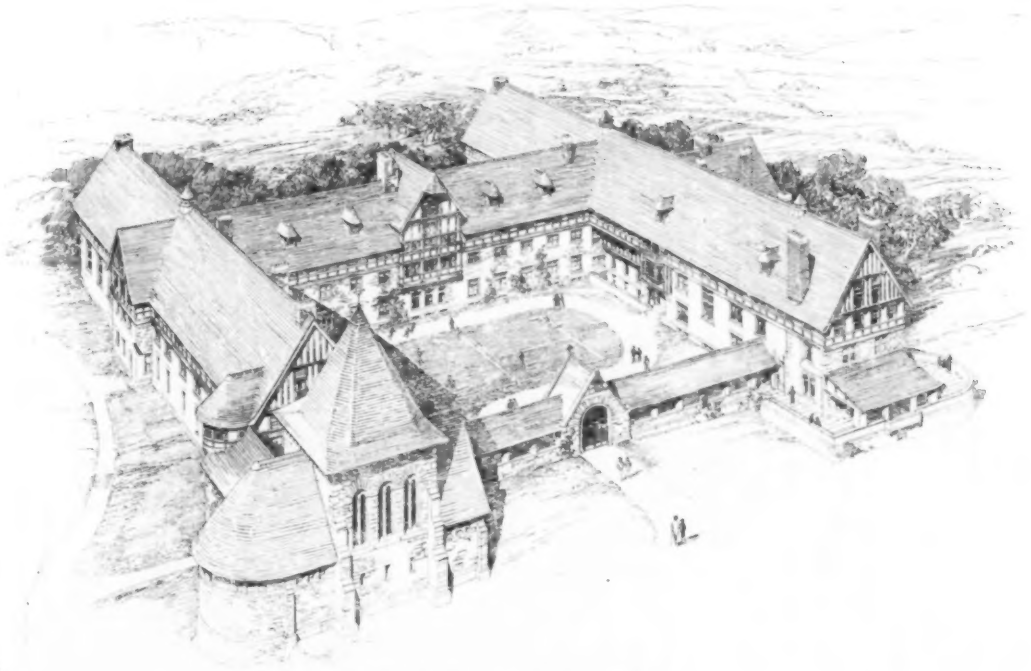
opposite the main window wall, so that, passing at once to the colder side of the room, it will fall to the floor and be withdrawn through a floor register underneath the point where it entered. Theoretically, and under favorable conditions of the wind, that may be right, but I believe the most carefully conducted experiments show that the best results are obtained when the circuit is, so to speak, parallel with the principal window wall rather than at right angles to it.

Among other heating equipments a sufficient amount of direct radiation should be provided for warming cold hands and feet and for the rapid drying of wet overclothing, including mittens and overshoes. The ventilation of the water-closets and other plumbing is of great importance, but it is less complicated than that of the class rooms, the one essential point being the rapid and certain removal of the air in the room. Stress is sometimes laid upon the need of outside windows for water-closets. For light they are desirable; for ventilation, quite the contrary. Placed in the center of a building with only an upward flue or outlet, the closet is virtually in the bottom of a chimney, and there is no danger that any adverse wind will drive the atmosphere of the room into other parts of the building; but outside windows, unless always closed, are liable to prevent, rather than aid, ventilation.

With the growing demands upon public schools, the basement is rising into prominence. It must be light, dry, well-ventilated, clean. It should contain at least a part of the toilet rooms; it should be easily

STATE NORMAL SCHOOL, STEVENS POINT, WIS.
Dwight H. Perkins and George Selby, Architects.

accessible and have proper stalls for bicycles. It should contain rooms for informal gymnastics or other exercise, and lunch rooms of ample size. If a proper manner of eating is not an essential branch of a liberal education, it ought to be.



ST MARK'S SCHOOL, SOUTHBOROUGH, MASS.
H. F. Bigelow, Architect

In addition to the recitation and class rooms, all large buildings should contain a library, a principal's room or suite of rooms, and one or more smaller rooms, furnished with whatever will make a comfortable resting-place for teachers during the occasional moments of leisure. Such rooms should have a special toilet room adjacent, and near the teacher's room there should be a small room for pupils who may be suddenly taken ill. Closets and store rooms for books and stationery, with lifts connecting the different floors, are in order, and large buildings three or more stories in height should have elevators adequate at least for teachers and pupils to whom climbing stairs is painful and injurious. Each class room should have cupboards with glass doors, and long drawers for maps and charts. In brief, there should be explicit provision made for the preservation and orderly handling of everything used in the school. There should be not merely picture moldings (which are often put up under the delusion that in themselves they are decorative), but good pictures. Brackets and shelves for casts, growing plants, and other appropriate ornaments are as legitimate school furniture as chairs and desks.

The construction of school houses should be absolutely simple and

SCHOOL BUILDING, DISTRICT NO. 2, ST. LOUIS CO., MO.
J. Harry Randall & Co., Architects.

durable. The chronic burden of bills for school-house repairs proceeds mainly from false economy and the employment of dishonest contractors and incompetent workmen. Whether a building should be fireproof is a financial question. If it is expected to serve two or more generations without change, it ought to be indestructible by fire, which means also able to resist the decay and deterioration that are inevitable when any part of the essential structure is of wood. A fireproof building is also to a great extent sound-proof. The floors of vestibules, corridors, and toilet rooms should be of tiles or marble and cement, and the

KERSHAW SCHOOL, CHICAGO, ILL.
J. J. Flanders, Architect.

fittings and dwarf partitions of the latter should also be of marble. The rooms containing the latrines and urinals should be of such construction that the entire room—floors and walls—may be freely washed with a hose.

It is unfortunate that, while abundant land around school houses is easily obtained in the country and suburban regions, where it is the least needed, in cities, where open space is infinitely more to be desired, it is denied for economical reasons. But cities that can afford space for public squares, which in many cases are mainly occupied by idlers, ought to afford needful room for the well-being of the children. The public park is for show, which is good; the play-ground is for temporal salvation, which is better.

As for the visible architecture of school-houses, we shall have none

that is good, until tradition and fashion are cast aside for utility. There are no public buildings for which money should be more freely spent, than for school-houses. Nowhere else is the highest architectural art more effective. It is also true that there is no justification for the apparently frequent assumption that it is well to spend freely on high schools, while anything that gives shelter from the elements will answer for the primary. If any children need more than others the beneficent influence of art and refinement in public schools, they are those to whom these things are elsewhere unattainable.

Without attempting to suggest appropriate "styles," it is clear that fitness, the cardinal virtue of all architecture, requires grace, lightness, and elegance, rather than solemnity, gloom, or even what sometimes passes for solidity and dignity. There is no doubt that the educational value of Richardson's work has been seriously impaired in many ways by his imitators. The architectural vagaries and aberrations which seem to have been borrowed from the decadence of the so-called "Queen Anne" are irrational and offensive. A beautiful tower as a civic ornament is a joy forever, and it may as well be attached to a high school as to any other public building. But the turrets and domelets and fantastic dormers and other roof excrescences that are applied for the sake of diversifying the "sky lines," or "relieving" some broad expanse of roof, have neither artistic nor educational value. There is much to be said in favor of flat roofs. Indeed, almost everything is in their favor from the utilitarian, constructive, economical, and sanitary point of view. Is the modern architect incapable of good composition and design without virtually disregarding these qualities?

After all, there is little hope that we shall have even good architecture, still less the best, while decisions concerning architectural merit are left to the authorities of the average city government, or, worse, to others who are liable to be influenced by sinister motives. If we could have a wise, impartial criticism of all public buildings which would really instruct, instead of the always ignorant and invariably fulsome comments of newspaper reporters, it would be a forward step; if the people whose money is spent for unworthy buildings could be taught to discriminate between the good and the bad, and made to understand that an architectural monstrosity, or, what is perhaps worse, an architectural platitude, is a crime, we should be still farther on the road to architectural reform. For this and many more reforms we must wait until ignorance, vulgarity, and vice are consumed, and their ashes swept away, by the steady light and consuming fire of universal education.

THE MANUFACTURE OF STEAM.

By a Staff Writer.

IT is well known to our readers that, at the instance of the Boston Manufacturers' Mutual Fire Insurance Company (Edward Atkinson, president), many very thorough investigations of various subjects affecting the construction and operation of factories and workshops have been conducted, as a result of which great improvements and great changes have been made on many points of the utmost service to the engineers and their clients. Among these may be named an almost complete revolution in mineral lubricating oils, and the establishment of lubrication as a department of established science on fixed rules; the sorting of safe and suitable steam-pipe coverings from those which were either dangerous or ineffective; the development of absolute rules for the lay-out of service pipes for fire purposes and for exercising a clear and suitable discrimination in the choice among the many varieties of fabric hose; improvements in fire pumps; and many other points.

A recent investigation of the use of suitable materials as fire retardents upon extensive wooden surfaces may be referred to, the report of which has lately been distributed. Within the next two months, as we are informed, reports of exhaustive experiments on the latest types of steam pipe coverings, boiler laggings, and the like, may be distributed, and also one on a very recent discovery, as it may be called, of the relative light and heat transmitted and diffused by the use of ribbed glass in place of plain glass in glazing, which may lead to an almost complete revolution in the glazing of factory and workshop windows, and which will have a very important bearing on the windows of school-houses, college buildings, libraries, and art galleries. All these have a direct and positive connection with the removal of dangers from fire; the last named may make it possible to entirely abandon the use of hazardous window shades in textile factories.

Mr. Atkinson considers it expedient to attempt to bring the manufacture of steam under simpler rules than those now open to engineers or to the owners of steam plants. As this does not come directly within the function of the underwriters, a circular was lately addressed to steam users, suggesting a contribution to a Steam Users' Association (corresponding to one which has existed for more than 40 years in England regarding which Mr. Atkinson obtained information after he had undertaken the work) for the purpose of making an attempt to

reduce the whole subject to terms of easier comprehension than those now in use. The rules to be established were thus set forth in Mr. Atkinson's original circular proposing the investigation, *viz.* :

First—For preparing the ground for a boiler plant so as to avoid wasting heat in baking the ground beneath?

Second—For the kind of brick and other materials (aside from a few fire bricks) which may be used in the main part of the boiler setting?

Third—For the selection of a boiler?

Fourth—What kind of lagging to use to prevent radiation of heat from boilers?

Fifth—For the prevention of smoke through the complete combustion of the fuel, or upon any other point relating to this subject?

Sixth—For the construction of the chimney, its height and section?

The circular went on to say :

The writer has endeavored to get systematic information on these points by a circular carefully prepared by experts and sent out. The replies were few in number, many of them incomplete, and nearly all of them at variance each with the other.

In order to remedy this fault in our practice, the following suggestion is submitted : The undersigned, advised by a committee of the directors of the Boston Manufacturers' Mutual Fire Insurance Co., will select two competent men, well-trained, and perhaps of some experience in the practice of steam engineering, who shall not have been committed to any special type of boiler or to any existing method of manufacturing steam. These two men, with such assistance as the subscriptions may warrant if this plan is accepted, will be assigned to the duty of developing rules for the manufacture of steam in the safest and best manner. One will be assigned to duty in Great Britain, the other in New England and the Middle States. The co-operation of large steam users who are not insured by us will be asked. The plan for this undertaking will be prepared under the advice and with the aid of our present corps of engineers and inspectors, with such outside assistance as they may secure. The undertaking may occupy twelve months. The results will be put in type, and will be distributed among the subscribers to this investigation. Such documents may be copyrighted or may be made public, at the discretion of the committee under whose charge the work will be done.

This investigation will not be undertaken unless the amount subscribed shall be deemed sufficient for effective work by the committee in charge. A secretary will be employed to keep the books and records. The specific records of the practice in each mill yard which may be disclosed will be strictly confidential. If results are compiled, no names will be given, but each establishment will be designated by a number, that number being disclosed only to the representative of that establishment.

We learn that a sufficient number of establishments and boilers have combined to make a beginning, and that the work is already under way. The general supervision will, of course, remain with Mr. Atkinson, but, as he does not claim to be an expert, the charge and direction of the investigation will be under Professor Peter Schwamb, of the Massachusetts Institute of Technology. Mr. Robert Sever Hale has been chosen to conduct a part of the investigation, and, when the

subject has been a little more developed, another expert will be selected,—one of the two to be sent abroad for the study of foreign steam plants. Mr. George Atkinson, late treasurer of the Massachusetts Cotton Mills, acts as the secretary of this undertaking, which it is the present intention to continue for a year. If, however, the result of the work of the first few months should warrant it, a permanent organization may be made for the purpose of testing all new devices and bringing order into a subject which is now in a state of considerable confusion.

We are informed that the promoters of this enterprise do not solicit, and have not solicited, anyone to contribute. The opportunity is simply offered to any steam users, engineeers, or others to become members of the association on the contribution of $3.00 per boiler, which will entitle them to all the reports and results that may be made from time to time at whatever they are worth. That opportunity, as we are informed, is still open, and will continue to be open during the next few months, unless experience proves that the work can be better done in some other way, or that the funds will not suffice. On the latter point little doubt need be felt. Mr. Atkinson considers the fund now in his hands, or very certain to be placed in his hands if he needs any more, ample and sufficient for the work he is contemplating.

POSTSCRIPT. As we go to press Mr. Atkinson informs us that "Progress Report, No. 1" is now in press, and will be ready for distribution to subscribers within a few days. It will give specific information as to the progress that has been made in the work of investigating the following subjects: Loss of heat into the ground; air leakage through settings; smoke prevention; and the choice of boilers and settings. In regard to the last point, the report will say: "It is well known that most of the boiler tests appearing in trade circulars are unreliable. We are pleased to report that many reliable tests, made at technical schools and by well-known engineers, have been placed at our disposal. The work of bringing them to a common standard and tabulating the results is now well under way." Copies of this first report will of course be supplied to those who now desire to become subscribers.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE ENTIRE RANGE OF AMERICAN AND ENGLISH ENGINEERING LITERATURE.

INTRODUCTORY

THE aim in this Review and Index is, (1) to give concisely written expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published currently in the scientific and industrial press of the United States, Great Britain and the British Colonies; and (3) to afford, through our Clipping Bureau, a means whereby all or any portion of this literature may be easily procured.

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The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. Serial publications are usually indexed only on the appearance of the first installment, and this the original notice may be found by consulting previous issues. The titles and addresses of the majority of the journals reviewed are given in full below, but only abbreviated titles are used in the Index. Other abbreviations employed are: Ill=Illustrated.; W=Words; Anon=Anonymous.

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American Gas Light Journal. *w.* $3. New York.
American Geologist. *m.* $3.50. Minneapolis.
American Journal of Science. *m.* $6. New Haven.
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American Miller. *m.* $2. Chicago.
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Architect, The. *w.* 26*s.* London.
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Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science. *w.* $5. Lancaster, Pa.
Scientific American. *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O
Scientific Quarterly. *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, New York.
Social Economist. *m.* $2. New York.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technology Quarterly. $3. Boston.
Tradesman. *s-m.* $2. Chattanooga, Tenn
Trans. Am. Ins. Electrical Eng. *m.* $5. N. Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York
Transport. *w.* £1. 5*s.* London.
Western Electrician. *w.* $3. Chicago.
Western Mining World. *w.* $4. Butte, Mon.

ARCHITECTURE & BUILDING

Index to Architectural Illustrations.

UNDER this heading a portion of the space in the ENGINEERING MAGAZINE will, each month, be devoted to cataloguing the more important illustrations that appear in the architectural press. The number of professional publications is now so large that an index to this essential feature of architectural journalism is a necessity to the busy architect. The classified index, the first portion of which is published in this number of the MAGAZINE, will enable the architect to tell at a glance if any recent publication contains an illustration of a subject interesting to him.

In addition to preparing a monthly list of illustrations, some of the more important of them will be singled out for comment and review, so that the MAGAZINE will hereafter present an absolutely comprehensive survey of architectural work and literature. This field is unoccupied in architectural journalism, and, it is believed, will materially add to the value of the MAGAZINE.

The illustrations indexed will include only those published in the plates of architectural journals; minor illustrations in text, and the photo-engravings and other illustrations of the general magazines, being omitted altogether, as without the scope of this work.

The Twenty Ninth Annual Convention of the American Institute of Architects.

THE proceedings of the Institute of Architects, which met at St. Louis this year, are summarized in the *American Architect* (Oct. 26), and fully reported in *Architecture and Building* (Oct. 19 and 26). The papers read were strictly technical, including "Coöperation *vs.* Competition," by Normand S. Patton, of Chicago; "Suggestions by Which a Greater Influence may be Exercised by the Institute among the Architects of the Southwest," by James B. Cook, of Memphis; "Prevention of Staining of Plastering on Damp Walls and Fire-proofed Surfaces," by Louis De Coppet Berg; and "Woods of Washington," by C. W. Saunders. Several other papers were omitted, owing to the absence of their authors. In addition one evening session was given up to a eulogy of the late Richard M. Hunt by Henry Van Brunt.

In his introductory address President Daniel H. Burnham referred once more to the operations of the government architectural office in the treasury department, but the most notable part of his address was the suggestion for a permanent home for the Institute, including the gathering of a library. He urged that the wealthy friends of the Institute should be called upon to provide this house, which unquestionably would add to its prestige, and give it a value in the public eye which it cannot have while it has no permanent quarters.

That the idea is a good one every friend of the Institute will admit. A very considerable source of strength to the Royal Institute of British Architects in London is its permanent home and its staff of permanent officials. But it by no means appears why the funds for this purpose should come from outside the Institute. It has long been the custom among certain classes of public organizations to depend upon others for assistance; the help rendered by the theatrical profession to many charities is a case in point. But are the architects of this country in such financial straits that they cannot themselves build a home for their own great organization? It would seem much more reasonable, business-like, and straightforward to erect a large office building, as the *American Architect* half-jokingly suggests, which would be a source of revenue to the Institute, and the funds for which could be secured in a business-like manner, without appeals to charity.

Nor would the funds to support such a

building be small. The Royal Institute has a handsome income from the fees of its members; it publishes a handsome journal; it has a large library; and its running expenses are not slight. The library is large, but it is chiefly made up of gifts and donations from members, no more than £100 being expended yearly for the purchase of books. It is no wonder, therefore, that the splendidly endowed Avery Library in Columbia College should be larger and richer than the library in London. It would be a pity for the architects of this country to undertake to duplicate the collection that the liberality of Mr. Avery has supplied for their benefit in New York. Whatever work the Institute may undertake in connection with a library should be done in conjunction with the Avery collection, which, in New York, is as accessible to the architects of the United States as any other collection would be in any place.

Another important matter brought before the meeting was that of membership. This comes up annually, but this year an urgent necessity for modification in the conditions of membership was freely recognized. The matter was frankly referred to by Secretary Stone in his report, in which he spoke of the systems of examination adopted by the Royal Institute of Architects, which thus gives to its members a degree of architectural standing in the profession without the help of a license law.

This is unquestionably the most important matter the Institute will have to consider until it is settled. True, the profession at large is in favor of a license law for each State, or, rather, for a uniform license law which would lead to a uniform practice of architecture. But much of this support for license comes from a misunderstanding of its nature and of its application to professions and occupations already licensed. The profession has the means within itself to accomplish more for the betterment of architects and of architecture than fifty license laws. The admission of this fact by the Institute is a circumstance of no small importance, and it should have due weight.

Convention Halls.

MR. DANKMAR ADLER contributes to the September and October numbers of the *Inland Architect* an interesting paper on the building of convention halls, full of good sense and valuable suggestions. Mr. Adler has fitted up no fewer than four great convention halls,—for the Republicans in 1884, 1888, and 1892, and for the Democrats in 1884,—and he speaks, therefore, with authority.

While it ought to be an easy matter to house a national convention of nine hundred delegates, forty or fifty reporters and correspondents, and as many pages and telegraph operators, the American people insist on gathering in large numbers at these times, and greatly complicating the problem of arrangement and disposition. The first step is to provide seats for the delegates, who require ample space, owing to the sometimes protracted length of the sessions. Ample passage-room must also be secured in this part. The platform for the chairman and secretary must be high enough to enable these officials to see from it the face of every delegate. About 7½ ft. was found a good allowance to each delegate, and 5½ to each alternate. Utmost convenience is necessary for the telegraph operators and reporters, and even the presence of distinguished guests entails a burden upon the architect.

The greatest difficulty, however, is with the audience. Every member wants to see every delegate and all the officers, and hear every word. In banking up seats and laying out isacoustic curves and determining sight lines, it must not be forgotten that the delegates occupy a space of from 6000 to 7000 sq. ft., and that a speaker in whom the entire audience is interested should be able to stand anywhere within that area and face in almost any direction.

The convention proper thus comes in the center of the hall, the speakers being arranged as nearly as can be on the lines of the Scott-Russell isacoustic curve. A low ceiling or sounding board over the delegates would be desirable, but it is impracticable on account of the audience, which wishes to see everything. There should be no standing room, the ushers, pages,

and others necessarily employed upon the floor of the convention affording a standing audience of considerable extent. All seats should be legibly marked, and the division into sections carefully distinguished. Aisles should be covered with matting, and the space under the hall entirely closed to outsiders. Stairs must be wide, an allowance of 1½ to 2 ft. for every 100 persons using each flight being reasonable. Stairs wider than 5 ft. should have intermediate rails. They should be strong, not too steep, with broad landings and no winders.

The architect's supervision of this work is of the most exacting kind, and frequently compels personal examination of every part of the hall after each meeting. Ventilation and heating are necessarily of the crudest sort, but the preparation of the working drawings entails a vast quantity of labor, which is necessarily minute. It is a work that brings little thanks to the architect, yet these convention halls are a not unimportant item in the many problems to be met and solved in architectural practise.

The Use of Cast-iron Columns in Building.

THE use of cast-iron columns in building is deprecated editorially by *The Engineering Record*, in a recent article calling attention to the fact that the coroner's inquest "brought forth no demonstrative evidence to the effect that the fractured iron columns were not the cause of the much-discussed fall of the Ireland building in New York city." This evidence indicates a strong probability that defective foundations were the immediate cause of the accident; but, in our contemporary's opinion, the evidence was not conclusive on that point. "The insidious character of cast-iron in columns for building has caused such columns to be discarded from the practice of civil engineering in bridge building, their liability to crack and fail rendering them unfit for this class of work. If not fit for bridge-work, how can such columns be reliable for buildings?" The *Engineering News* thinks they should be discarded from architectural practice. On this point it says:

"It is true that all portions of all cast-iron columns are not positively bad, but engineering experience has many times demonstrated that few or no cast-iron columns can be relied upon to be positively good. High internal stresses due to inevitably irregular cooling, gas and air holes invariably present, dangerous irregularities in thickness, and extreme variations in quality of material in the same piece, lead to cracks and failures, which, both before and after loading, are by no means infrequent. The cracked, patched, and reënforced base castings along some portions of the elevated roads of New York city indicate with sufficient clearness just what kind of metal cast-iron is. If the cast-iron columns in use in the buildings of any large city were equally exposed to view, they would illustrate an interesting chapter in building construction, in which, incidentally, tenpenny-nail shimming would add materially to the total interest of the matter. There is little doubt that so much of cast-iron column practice as is now left is wholly due to the concealment of these members in the completed building. Were they as open to inspection as bridge members, they would be relegated to 'innocuous desuetude' in short order. No brittle material which goes all to pieces without warning when it fails, as Mr. Brown admits cast iron does, is any more than indifferently qualified at best for structural purposes; and, when such admirable materials as wrought iron and steel can be employed at practically no additional cost under proper design, cast-iron columns have absolutely no *raison d' être*.

Faulty Fire Escapes.

AN examination of fire escapes made by Owen B. Maginnis leads him to express the opinion in *Architecture and Building* (Aug. 10) that these appliances on flats, tenements, and factories are in the majority of cases entirely useless. He particularly condemns that kind of so-called fire escape which consists of platforms, one at each story, each having an opening in the center or side connected with an iron ladder to the next one below; yet this is one of the most commonly adopted devices,

Illustrations of the Month.

THE difference between architectural design in New York and Chicago has seldom been more strikingly shown than in the design for the new department store for the Siegel-Cooper Co. on Sixth avenue (*Architecture and Building*, Oct. 5, 1895). The Chicago building occupied by this firm is a plain, simple, straightforward structure. It is rectangular, without ornament of any sort,—nothing save the vertical and horizontal lines of granite with which the building is built. It is satisfactory in its severity, and because no "architecture" was attempted. It might have been hoped that, when this firm decided on opening a New York store, they would employ a Chicago architect and give New York an example of the fine commercial architecture of the western metropolis. Nothing of the sort was done. A New York architect was selected, and a design in the most approved New York style was chosen. That is to say, a building of seven stories, one of which is hidden behind the balustrade on the roof, with ornamental entrances, varied treatment of the floors, pilasters, panels, and a tower in the center of one front,—a design that could not have been thought of outside New York, and which is full of the vulgar display that characterizes most of the dry goods architecture of the metropolis.

After the fussiness of this design, it is refreshing to review once more the fine conceptions worked out in the Wainwright and Union Trust Buildings in St. Louis, photographs of which are published in the *American Architect* (Oct. 12). Both these buildings are entirely satisfactory in being ornamental and artistic. What ornament is used is employed naturally and with good effect. The silhouette is fine, the detail good. There is nothing wanting to secure the greatest of artistic successes in commercial design.

That commercial design in the west does not often touch the high standard created by Messrs. Adler and Sullivan in their St. Louis buildings is borne in upon one by the study of some new designs published in the *Inland Architect*. An office building for T. A. Davies by Jenney and Mundie is a twelve-story building, sufficiently plain in design, with a large bow window on each side from the fourth to the eleventh story. The design shows that difficulty in getting started which is apparent in the work of most architects; that is to say, a basement of two stories and an entresol before the superstructure, or main portion of the design, is entered upon. The effect of the upper part, and indeed the whole design, is injured by the large blocked frames which enclose the windows, and by the heavy lines carried around the bows below and above the windows. It needs more than a second glance to satisfy one that this is not a horizontal design, cut up into twelve layers.

The Century Building in St. Louis is an unhappy example of cutting up a ten-story structure by horizontal lines. Situated on a corner site, it has a long and a short side, both of similar design. A basement of two stories is surmounted by the inevitable entresol. The superstructure is only four stories high; the windows are arranged in bays with circular heads. Then come the frieze story and a broad cornice. Logically the building comes to an end at this point, but two additional stories are added above the cornice, with another cornice above, and a solid balustrade, surmounted on the corners by standards carrying lights. There is little detail shown in the drawing. The building for the Bell estate, Cincinnati, illustrated in the same paper, is an extraordinarily fussy design, with plate-glass walls below, and bow windows, windows within bays and without, balconies, cornices, horizontal bands, a section with pilasters, an attic story, and a balustrade with obelisks.

ONE of the many striking facts connected with the advancement of architecture in America is that it is almost wholly necessary to depend on the public spirit of our private citizens for really notable contributions to ornamental structures in our great cities. This is true, also, of the country; but in rural districts the traveller, in his enjoyment of the natural scenery, may well overlook the absence o

ornamental houses. The cities, on the other hand, present the dreariest appearance possible, if there are no handsome houses or imposing business buildings, both of which classes of buildings are due entirely to private enterprise.

The rich men of New York are gradually building for themselves more or less sumptuous residences, some few of which must already be counted among the most notable structures of the city. Among the most recent of these is the residence of Mr. C. P. Huntington, at Fifth avenue and Fifty-Seventh street, some fine photographs of which are published in *Architecture and Building* (Oct. 5 and 12). Mr. Huntington is one of the very rich men of New York, and it might readily have been expected that he would have built a rich and splendid mansion. His house is big enough, and costly enough, and its situation is all that could be desired, but as a design it is totally uninteresting, and, far from being an ornament to Fifth avenue, is quite the reverse. It is somewhat irregular in plan, yet entirely devoid of picturesqueness. It is three stories high, with a moderately-sloping roof, whose dormers are partly hidden by the balustrade at the top. The walls are of rough stone, that of the basement being slightly heavier than the upper portion. The windows here are likewise plainer, with inner frames, while in the upper stories they are enclosed within columns and entablatures, with pointed pediments on the second floor. Of ornament there is scarcely anything, save a series of grotesque masks in the first story windows,—most unpleasant things to look at, though possibly having an economic value in frightening away burglars and other improper persons.

As a whole, this is one of the most disappointing edifices built of late. What relatively small amount of detail is included in the fronts is cold and hard, without even that air of correctness which sometimes redeems unfeeling ornament from utter failure. The house is neither stately or magnificent, though large enough to exhibit both these qualities. That it is satisfactory to its owner is to be presumed, because he has had it built, but it is a most conspicuous failure as an architectural adornment to New York.

THE competition for the West Ham Technical Institute, which has recently been decided in London, has attracted a good deal of attention in England, and has been copiously illustrated in the English architectural press (*Builder*, Oct. 5; *Building News*, Oct. 4; *Architect*, Oct. 11, 18, 26). It is a characteristic English Institute, including a lecture hall, library, technical schools, meeting and recreation rooms, and a variety of minor apartments grouped under a single roof, the programme being quite unlike anything the American architect has to consider in ordinary practice. The estimated cost of the projected building is $200,000.

Seventy-three designs were presented in the competition, of which we need concern ourselves only with the successful one. In plan this is simple and admirable, with the lecture hall, opening upon the main front, in the center, the library and allied departments on one side, and the school and miscellaneous rooms on the other, and extending around on the fourth side. Much ingenuity is displayed in the plan, which necessarily included considerable dissimilarity and irregularity in the disposition of the various apartments of this somewhat mixed interior.

The dissimilarity extends to the designs of the façades, which are drawn in an Elizabethan type of classic of decided English character, with a good deal of freedom in the treatment, though by no means free from faults which further study will eradicate. On one front is a porch with a segmental coping supported on stooping caryatides, which form the entrance to the lecture hall. On each side are segmental topped windows with heavily-blocked frames and large keys cutting into a broad foliated frieze. On this stand applied columns carrying the main cornice, with a regular series of windows in the upper part of the wall, separated by small columns. Another front has for its main feature a series of decorated semicircular pediments, which are also repeated on the first front. The

upper story here is again more highly decorated than the lower. The design is not of the first importance, but it is a straightforward attempt to produce a structure useful and ornamental, and still keep within the amount set apart for the building. There is no shoddy classicism in this conception, no importation from foreign lands; it is a thoroughly British building, designed for British purposes.

THE *Architectural Review* (No. 8, Vol. 3) publishes the design which won for its author the McKim Roman Scholarship and the Columbia College Fellowship in Architecture. The problem was the relatively simple one of a bank for savings, characterized by a practicability and usefulness which does not always distinguish the problems set for our young architectural students. That this design was the best of the series submitted in the competition need not be questioned; the standing of the judges who made the award does not leave that question open to debate. But whether it is useful for young men to design exercises in the French type of classic architecture as a foundation for their future work is a much more serious matter.

Many banks for savings throughout the country have, within the last few years, erected large and costly buildings for themselves, which are more or less ornamental to the districts in which they are situated. But the very richest of them has not attempted so magnificent a palace as this young college student has figured to himself. It is true, the building was not intended to be built, and a certain license is allowable in a mere design on paper which would not be tolerated in a design that was to be executed. Yet the fact of this allowance, the ample space given to the site, the absence of a cost limit, and the general splendor with which the conception has been carried out, at once remove it from the realities of architecture, and place it among those interesting fancies with which the young men in Paris are taught to design. Admitting that these elements of unreality are admissible in a case like the present, we have here a design of considerable success. The use of two series of Ionic columns of different heights has not been entirely successful, but, as a whole, it is quiet and subdued building.

When its author gets to designing real banks for savings, he will unquestionably, if he has a proper regard for the convenience of the patrons of his building, provide a direct means of access from the street. An ornamental wall, with a high pedestal surmounted by a statue, with a lion at either end, forms a sufficiently satisfactory frontage according to French ideas, but there is an extended popular prejudice in America in favor of a direct stair from the street to the main entrance.

Index to Illustrations.

ART GALLERIES. The Olney Art Gallery, Cleveland, O., by Coburn, Barnum & Denes, In. Archt., Oct.

CHURCHES. Proposed west front, Manchester Cathedral, by B. Champneys, Builder, Oct. 12.—Church of the Most Holy Redeemer, Chelsea (interior) by E. Goldie, ibid.—Church of St. James, Spanish Place, London (interiors) by Goldie, Child & Goldie, ibid.—A Labor Church (plans and elevations), by G. L. Morris, ibid, Oct. 12.—Proposed P. E. Church, Eckington, Washington, D. C. (interior), by W. & G. Audsley, Archt. & Build, Oct. 26.—Riverside Baptist Church, New York, by W. E. Bloodgood, ibid, Oct. 19.—Private Chapel, Pyrgo Park, alterations by P. H. Roberts, Amer. Arch., Oct. 26.

CLUB HOUSES. Baltimore Club House, Baltimore, Md. (plans and views), by J. A. & W. T. Wilson, Amer. Archt., Oct. 19.—Club House of the Delta Kappa Epsilon Society, Middletown, Conn. (details), Archt & Build., Oct. 5 and 12.

COMMERCIAL BUILDINGS. Union Trust Co. Building, St. Louis, Mo., by Adler & Sullivan and C. K. Ramsay, Amer. Arch., Oct. 12.—Wainwright Building, St. Louis, by the same, ibid.—McDonald & Taylor Building, Fort Wayne, Ind., by Wing & Mahurin, ibid, Oct. 5.—Design for Halifax & Huddersfield Bank, Halifax, by Tarbolton & Tugwell, ibid, Oct. 26.—Departmental Store Building for Siegel, Cooper & Co., New York, by DeLemes & Cordes, Archt. & Build., Oct. 5.—Chapin Building, Buffalo, N. Y. (elevation), by E. A. Kent, Brickbuilder, Oct.—Business Premises, by F. J. Cooper, Builder, Oct. 26.

HOUSES. For C. P. Huntington, New York, by G. B. Post, Archt. & Build., Oct. 5 & 12.—Study for F. G. Russell, Bronxville, N. Y., by Jardine, Kent & Jardine, ibid, Oct. 19.—For F. E. Lay, Westfield, Mass., by E. A. Ellsworth,

ibid, Oct. 26.—For Dr. W. S. Bryant, Boston, Mass. (staircase-hall), by W. Y. Peters, Amer. Archt., Oct. 5.—For E. L. Sheppard, Wissahickon Heights, Philadelphia, Pa., by Hazlehurst & Huckel, ibid, Oct. 12.—For J. E. Devlin (mantel), by Wheelwright & Haven, ibid, Oct. 19.—For J. C. Hoagland (exteriors and interiors), Seabright, N. J., by Shepley, Rutan & Coolidge, ibid, Oct. 26.—For Hon. A. Wood, Woodmont, Pa. (working drawings and details), Archt. Rev., No. 8, Vol. 3.—House in Detroit, Inland Archt., Oct.—For C. H. Taylor, Chicago, by Treat & Foltz, ibid.—Competition for City House, Brickbuilder, Oct.—"St. Keverne," Harrow-on-the-Hill, by A. Mitchell, Archt., Oct. 25.—Gosford House, Staircase Hall, by W. Young, Builder, Oct. 26.—"Teith View," near Doune, N. B., by Niven & Wiggleworth, ibid.—Small Town House, by F. J. Cooper, ibid.

LIBRARIES. Public Library, Fall River, Mass: accepted design by Cram, Wentworth & Goodhue; competitive designs by A. M. Marble; by Abbott & Thompkins; by C. H. Farnham (views, elevations, plans), Amer. Archt., Oct. 26.—West Ham Technical Institute and Public Library; accepted design by Gibson & Russell, Builder, Oct. 5; competitive designs by Clark & Hutchinson; by T. Davison, Archt., 11 and 18 (perspectives, elevations, plans, details).

PARIS EXHIBITION. Bird's eye view of scheme and plan, Amer. Archt., Oct. 19.

PUBLIC BUILDINGS. Design for Minnesota State-house submitted in first competition, by J. A. Schweinfurth, Amer. Archt., Oct. 19.—Imperial Institute, London; Canadian Conference Room, Australian Conference Room (interiors), by T. E Collcutt, ibid, Oct. 19—Fourteenth Regiment Armory, Brooklyn, N. Y., by W. A. Mundell, Archt. & Build., Oct. 26.—Hospital by J. B. Lord, ibid, Oct. 12—State Normal School, West Superior, Wis., by H. W. Jones, ibid, Oct. 26.—Police Station, Stoke-upon-Trent, by C. Lynam, Archt., Oct. 4.—James Street School, Auburn, N. Y., by J. A. Schweinfurth, Inland Archt., Oct.

HISTORICAL AND MISCELLANEOUS. City Hall, New York; measured drawings of elevation and section by L. F. Pilcher and C. H. Lum, Archt. & Build., Oct 19—Palazzo Vecchio, Florence; Envoi of the Rotch Travelling Scholarship, by W. H. Kilham (India ink elevation) Archt. Rev., No. 8, vol. 3.—Winning design for the McKim Roman Scholarship and the Columbia College Fellowship in Architecture, by J. R. Pope (elevation and plan), ibid.—Wolfgang's Kirche, Rothenburg, from water color by R. P. Spiers, Builder, Oct. 19.—Measured drawing of arcade in court of house on Via Arche, Acaligere, Verona, Brickbuilder, Oct.—Romsey Abbey, by C. E. Mallows and R. P. Spiers (with plan). Builder, Oct. 5.—Abbey of Jumieges after Cotman, Archt., Oct. 4, 11, 18, 25.—St. Mary's Church, Brading, Isle of Wight, by A. B. Bibb, Amer. Archt., Oct. 5.—Panfolfini Palace, Florence, by W. H. Orchard, ibid, Oct. 19. The Sun Dial, Walton House, by A. W. Brewill & B. E. Bailey, Builder, Oct. 19.—Crematorium and Chapel, by Tarbolton & Tugwells, Archt., Oct. 25.

HOTELS.—Hotel Cecil, Victoria Embankment, London (façade, plans, interior), by Perry & Reed, Builder, Oct. 19.—Hotel St. Nicholas, St. Louis, Mo., by Adler & Sullivan & C. K. Ramsey, Amer. Archt., Oct. 5.—Spencer House, Niagara Falls, N. Y. (view and pla by E. A. Kent, Archt. & Build., Oct. 12.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Architecture and Building in the American, English and British Colonial Technical Journals—See Introductory.

*1893. Schools and School-House Architecture. Ill. E. C. Gardner (Detailing the requisites to be observed in the location and construction of school-houses). Eng Mag-Dec. 3400 w.

†1934. Tenement-Houses and Dwellings for Workingmen in Glasgow. Allen B. Morse (Report to State Department. Treats of laws and municipal ordinances regulating construction and use; building rules and regulations; the houses and their inhabitants; corporation tenement houses). Sanitarian-Oct. 5500 w.

*1945. Bricks, Tiles and Terra-Cotta in America (Review of an extensive work by Charles Thomas Davis, with extracts. The reviewer thinks it a valuable work for all who employ clay as a material). Arch, Lond-Oct. 4. 3500 w.

*1951. The Churches of Norwich, Eng. Ill. (A brief account of the ancient churches of the place, which have escaped modernization and have only been sufficiently restored to keep them in a substantial condition). Builder-Oct. 5. 3500 w.

†1992. The All-Around Architect. C. H. Blackall (A consideration of the enormous extension of the field which a successful architect is required to cover, and advising young men to fit themselves to act both as architectural adviser and master builder). In Arch-Oct. 4400 w.

2004.—75 cts. Architecture from the Architect's Point of View. Ill. Albert L. Brockway (Differences between the public conception of architecture and that of the architect. The architect's point of view explained). Arch Rev-Vol. III. No. 8. 4500 w.

2014. The New York Clearing House (Describes the purpose and working of this financial institution, and illustrates and describes a new building for its accommodation recently designed in the Italian renaissance style, by R. W. Gibson). Sci Am Sup-Oct. 19. 2700 w.

2038. Recent Chicago Tall Buildings. Ill. (A very thorough review of the engineering and architectural methods used in tall building construction). Eng News-Oct. 17. 2200 w.

*2047. A Twentieth Century Palace of Commerce. Ill. (A detailed description of the Em-

We supply copies of these articles. See introductory.

porium of San Francisco, suggesting that it would be interesting to place in the center of this "greatest building of its kind on earth," a museum showing by models or object lessons the development of commerce from its first dawning to the present time. An outline of commercial progress and a description of the construction of the building). Overland Monthly-Oct. 5400 w.

*2061. On the Bearing and Resisting Strength of Structures and That of Their Component Parts and Materials. Charles Baillairge (Read before the Quebec Asso. of Arch. Discussion of the subject with tabulated statements of the sectional area in square inches, of steel built columns to support the weights, the thickness of their component plates, the weight in tons to be supported and the corresponding prices at a uniform rate of five cents to the pound, &c., &c.) Can Arch-Oct. 3000 w.

*2062. Decoration of Public Buildings. C. L. Eastlake (Discusses the external conditions of works of art, dimensions, situation, light and means of representation, position, magnitude, form, etc.) Arch, Lond-Oct. 11. Serial. 1st part. 5800 w.

*2063. Speculations on Ancient Vaulting. (Descriptive of ancient methods, with quotations of accounts from ancient writers). Arch, Lond-Oct. 12. 2800 w.

*2066. Short Forms of Agreements for Builders and Contractors. W. H. Stacpoole (It is proposed to give some short forms of agreements which are likely to be of use to persons engaged in the building trade). Ill Car & Build-Oct. 11. Serial. 1st part. 1500 w.

2095. Foundations of the Fisher Building. E. C. Shankland (Explanatory of the theory upon which the unusually short piles were used, with sections and plan. The theory is that there should be just enough cubic contents in the piles to squeeze the water out of the soil). Eng Rec-Oct. 19. 250 w.

2098. Prevention of Staining of Plastering on Damp Walls and Fireproofed Surfaces. Louis de Coppet Berg (Read at the convention of the Am. Inst. of Arch. at St. Louis. The author believes a permanent and successful remedy has been found). Am Arch-Oct. 19. 3200 w.

*2100. A Question of Church Style (Editorial discussion as to whether there is such a style, suggested by two churches, differing in character, recently erected in England for Roman Catholic worship). Builder-Oct. 12. 1300 w.

†2196. Maps, Plans, and Views of the City of Rome. R. Lanciana (With Especial Reference to a 16th Century Drawing of the city in the Burlington-Devonshire Collection). Jour Roy Inst of Brit Arch-Sept. 3500 w.

†2197. The Municipal Buildings of Edinburgh. J. M. Brydon (An interesting review of a book by Robert Miller, which is a sketch of the history of these buildings for 700 years). Jour Roy Inst of Brit Arch-Sept. 4000 w.

†2198. Architecture at the Exhibitions of the Royal Academy. R. F. Chisholm (A criticism of the system in vogue, and a discussion of the subject, with suggestions tending to correct the present evils). Jour Roy Inst of Brit Arch-Sept. 2800 w.

†2199. Káfiristán. Sir George Robertson's report (Origin and physical characteristics; villages and houses; the one-room house; houses of the better class; houses of the Presun Káfirs; a Káfir tower; the dancing place and gromma or church). Jour Roy Inst of Brit Arch-Sept. 4200 w.

*2200. The Hotel Cecil, London. Ill. (Description of the building and site). Builder-Oct. 19. 3000 w.

2206. Suggestions by Which a Greater Influence May Be Exercised by the American Institute of Architects Among the Architects of the Southwest, at the Same Time, the Elevation of the Profession before the Public. James B. Cook (A paper read at the Convention in St. Louis). Am Arch-Oct. 26. 2800 w.

*2216. Treatment of Outside Hard-Wood Finish. F. J. Thayer (Methods described). Ill Car & Build-Oct. 18. 1100 w.

*2217. Stencils and Stencilling. Ill. F. Parsons (An article written with the view of assisting the inexperienced). Ill Car & Build-Oct. 18. 2000 w.

*2218. Inlaid Work (Historical account). Ill Car & Build-Oct. 18. 1200 w.

2225. A Young Architect's Bicycle Trip in Europe. Francis H. Bent (Economic means of travel, and architectural study in the old world—Naples and Rome). Eng Rec-Oct. 26. 3500 w.

†2285. Mural Decoration in America. Ill. Royal Cortissoz (The author considers mural decoration as a half-sister of architecture. Work of artists of note considered, and a critical review of recent work given). Cent Mag-Nov. Serial. 1st part. 7000 w.

*2383. Bricks, Tiles, and Terra-Cotta (An editorial review of book by C. T. Davis). Builder-Oct. 26. 2000 w.

*2384. American Opinion on Architectural Education (A reprint of the report on education, drawn up by Mr. Van Brunt, as chairman of committee of the Am. Inst. of Archs., with some comments). Builder-Oct. 26. 3000 w.

2387. Richard Morris Hunt (A memorial address by Mr. Henry Van Brunt, delivered at the twenty-ninth Convention of the Am. Inst. of Arch. at St. Louis, Oct. 15-17, 1895). Am Arch-Nov. 2. 7800 w.

2388. Co operation versus Competition. Normand S. Patton (A paper read at the 29th Annual Convention of the Am. Inst. of Arch. suggesting a new motive for co-operation). Am Arch-Nov. 2. 3000 w.

2458. Tests of Long-Span Terra-Cotta Floor Arches. Ill. Gunvald Aus (The floor arches tested were in the new appraiser's warehouse in New York City. The floors are composed of 24-in. I beams supporting terra-cotta arches of 11 ft. 6 in., and 15 ft. 4 in. spans, the spans of the I beams bring generally 23 ft.). Eng News-Nov. 9. 900 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Tests of Paving Brick.

A LARGE number of cities in Ohio, Indiana, and Illinois have been paved with the vitrified brick made in that region; these States are particularly rich in shales of the Silurian, Devonian, and Carboniferous ages, and in impure fire-clays and Quaternary clays, though the latter are apt to lack uniformity and to be too easily fusible. *Paving and Municipal Engineering* (Nov.) abstracts from advance sheets from the annual report of the United States geological survey on the "Technology of the Clay Industry" as follows: "The heat required to vitrify a clay varies, and some of the fire-clays used cannot be said to vitrify. In the Ohio clays (Geol. Sur. O., VII, p. 138) it was found that the heat required to vitrify the clay or shale was about 1860 F. The fusibility seemed to be due partly to the alkaline earths and alkalies present. Iron did not seem to aid much in the fusion." The table given shows the vitrifying temperatures required for some Ohio clays.

TEMPERATURE OF PAVING BRICK KILNS IN DEGREES F.

Material.	Kiln at best heat	Kiln at high'st heat.
Fire clay.....	1862	1920
Shales	1800	1840

Three tests are usually applied to these brick,—absorption, abrasion, and crushing.

"From a large series of tests recently made by Mr. Ficks the following facts were developed:

"1. A brick which stands rattling well has ample crushing strength, and rarely chips under less than 5000 lbs. per sq. in., or crushes under less than 10,000 lbs. The crushing strength tends to vary with the resistance to abrasion, however, but more slowly and irregularly.

"2. The transverse strength also tends to vary with the resistance to abrasion, but more slowly and irregularly.

"3. The toughest brick usually absorb the least water, but exceptions occur."

Some valuable and interesting tests were recently made by the Ohio geological survey to determine the relative merits of fire-clays and shales for the manufacture of paving brick. Twenty-three varieties of shale brick, or bricks whose largest constituent is shale, were grouped together; fifteen varieties of fire-clay brick; four varieties composed of shale and fire-clay mixed in equal proportion; and the varieties made of Ohio river sedimentary clays.

RELATIVE RESULTS OF OHIO FIRE BRICK TESTS.

Kind of Clay	Abrasion.	Rattling	Crushing.	
			Square inches	Cubic Inches.
Shales	1.17	17.61	7307	1764
Fine clay..	1.62	17.32	6876	1678
Mixture...	1.41	18.72	5788	1400
River clay.	1.36	19.02	4605	1176

The Port Royal Dry Dock.

THIS important work, carried on under the supervision of the bureau of yards and docks of the United States navy department, is now ready to be tested. The cost will be about $500,000, and it possesses some new features of interest to engineers. *The Engineering Record* (Oct. 5) gives a description, from which the following is abstracted.

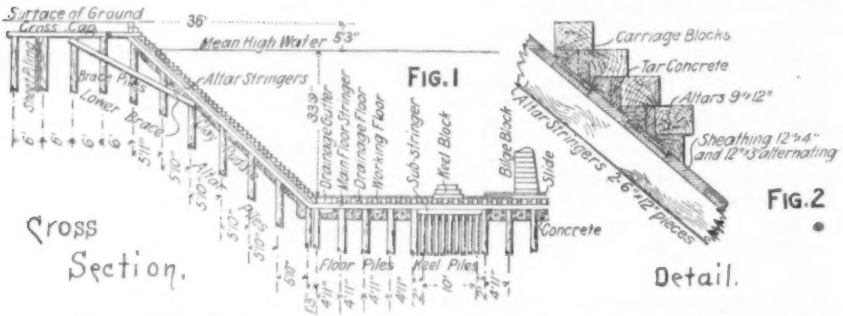
"Its general dimensions are given in the following table, which also gives similar data relating to other timber dry docks in this country.

	Port Orchard.	Port Royal.	League Island.	Brooklyn.
Length on coping*.....	625′	476′	500′	500′
Length on floor.....	573′6″	420′	439′10″	439′10″
Width on coping. ...	130′11½″	126′	130′	130′
Width on floor	67′11½″	84′	86′	86′
Depth coping to m. h. w..	7′	4′3″	5′	5′
Depth coping to floor	39′5″	33′6″	32′8″	32′8″
Draft over sill, m. h. w....	30′	26′	25′6″	25½′

* From head to inner gate sill when there are two.

"These figures may not be absolutely correct, as they are taken from unofficial sources, but they are believed to represent approximately the relative sizes of the different docks.

"The primary element of the body is a transverse rib running along the floor, up the sides, and out on or just below the surface of the ground. Each rib is supported on piles, which are spaced in one direction, as shown in Fig. 1, and every 4 ft. in the other direction, parallel to the axis of the docks. Along the center of the dock there are nine piles, driven very close together, and cut off 14 in. below the tops of the remainder. These nine piles are capped with a 14×16-in. substringer 13 ft. long, and on it and the remaining piles rests the 14×16-in. main floor stringer. In addition, short intermediate bents of five piles each and a 13×14×16-in. cap are placed between the main ribs under the central portion of the dock, where most of the weight comes. Most of the timber in the dock, including piles, is long leaf yellow pine; the keel and bilge blocks are of oak. . . . The space between the back of the altars and the sheathing is filled with hot tar concrete, mixed in the proportion of 1 barrel of boiling tar to 1 cu. yd. of hot, dry sand and gravel. . . . The drainage floor rests directly on the bed of shell concrete, and is bolted to the floor stringers. The system of drainage provides for the discharge of all water in the dock into the pump well, but it does not relieve the great pressure which might come upon the altar sheathing, if the earth behind it were to become filled with water." To prevent this, in a measure, 5×10-in. sheet piling is driven around the outer edge of the dock, and 2 ft. of clay puddle rammed behind the altar stringers, while the floor is supported on a 3-ft. bed of concrete, composed of 1 part by measure of Portland cement, 2 parts of sand and gravel, and 5 parts of oyster shells. "The dock is emptied by two Southwark centrifugal pumps with 42-in. and 40-in. discharge openings. They



are located in a pit with their center line below the mean high-water level, in order to keep the maximum suction lift down to about 21 ft. The contract capacity of the pumps is 70,000 gals. a minute. They are driven by a 24×24-in. vertical engine, with a fly-wheel 5 ft. 5 in. in diameter, directly connected with the pumps. The boiler plant consists of three horizontal return tubular boilers 16 ft. long and 72 in. in diameter, having 80 4-in. tubes. The steam pressure is about 80 lbs."

Heat Tests for Cement.

SPEAKING of the heat tests which cements are being subjected to to determine their time-resisting qualities, the *Engineering News* (Oct. 31) says: "Heat tests have shown much promise in this respect, although they have been but little adopted. They are, we believe, gaining more and more the attention of cement users, both in this country and abroad." M. Le Chatelier, in his report to the French commission, has taken the experiments of Prof. L. Tetmajer, of Zurich, as a basis for the following remarks: "In the course of time all hydraulic cements and limes employed in works of construction are disintegrated by the various influences of na-

ture. The longer a cement resists these attacks, the better it is. It would seem important, therefore, to be able to ascertain by tests the degree of this resistance.

"The causes of disintegration are many, but may be divided into two classes: (1) those which act only under certain conditions, as the action of sea water, frost, heat of the sun, etc.; and (2) those which act under all conditions, as water and carbonic acid. These latter are the less energetic in action." In durability tests the cement is generally molded into good-sized pats, or cakes, with thin edges; this shape renders cracks, scaling, etc., more readily observable. The pats are subjected to test at the end of 24 hours. Comparative tests were made in cold water, in air, in kilns up to 120° C. in a gas flame up to red heat, and in water brought to boiling-point in 1½ hours and kept boiling for 6 hours, with the following results:

"*Portland Cements.*—Of 139 cements tested, two only showed signs of disintegration after 3 years in cold water. In the tests in air 18 altered completely, and 7 showed less marked disintegration. The boiling or coking test destroyed 17 cements completely and developed cracks in 11 more. All the cements disintegrating in air were destroyed by the boiling test, but, while the disintegration in air became evident only after a year, it was developed by boiling in 6 hours. A certain agreement appears to exist between the time necessary to develop disintegration in air and in boiling water. The cements which disintegrated in air in less than 6 months could not resist the boiling water more than 4 hours, and those that stood in air only a few days disintegrated in boiling water in less than 2 hours. The results obtained do not admit of any definite relations being deducted on this point. The kiln tests and red-heat tests give results identical with the boiling tests. In conclusion, it may be said that the results of the tests on Portland cement demonstrate that for such cements the boiling test is excellent. It gives in 6 hours the same results that a test of a year's duration in air does.

"*Slag Cements.*—The boiling tests did not give such positive results as in the case of Portland cements; though it disintegrated the slag cements, which were certainly bad, yet it did not act satisfactorily on those which were doubtful.

"*Natural Cements.*—None of the heat tests were found suitable, and a hot-water test (at 50° C.) was recommended.

"*Hydraulic Limes.*—Same conclusions as for natural cements."

The article concludes as follows: "It appears from these tests that the use of the hot water gives a really accelerated test, since it is ended in 6 hours. No hydraulic lime or cement notoriously bad can escape the boiling test. It remains to be proven that all cements unable to stand the test are really bad."

The Chicago Drainage Canal.

THE trade catalogues of many of our most enterprising firms are often important contributions to knowledge, and deserve a place upon our library shelves. Of this type is a booklet of seventy-two pages with forty-four half-tone illustrations, giving a full description of the work in progress and the construction methods employed on the new Chicago drainage canal, and incidentally it describes the machines manufactured by the company itself, with their actual performance on the work. The book is supplied gratuitously by the Lidgerwood Manufacturing Company, with the title, "Contractors' Methods Employed on the Great Chicago Drainage Canal." Some of the most interesting features are thus described: "The main drainage channel of the sanitary district of Chicago extends from the south branch of the Chicago river, at Roby street, southward to Lockport, in Will county. From the end of the canal proper its flow will be conducted down a sharp declivity through the city of Joliet, then by way of the Illinois river to the Mississippi. In addition to performing the duty of a drainage channel, the completed canal will be a free ship channel, navigable for boats of 22 ft. draft. The work of the district will constitute about two-thirds of the entire cost of a ship waterway from Chicago to the Mississippi river, and it will be of as great

depth as the channel between St. Louis and New Orleans upon completion of the government work upon the Mississippi." The work was divided into mile sections, and consisted in the removal of earth, glacial drift, and limestone rock. The accompanying illustration will give the dimensions of rock and earth sections. The canal follows the course of the Desplaines river, which is subject to extreme floods, so that at one point a channel 13 miles long, bottom width of 200 ft. and side slopes 1 to 1, had to be constructed; and at another point 19 miles of levee was built to divert the river and save the canal from the effects of violent floods.

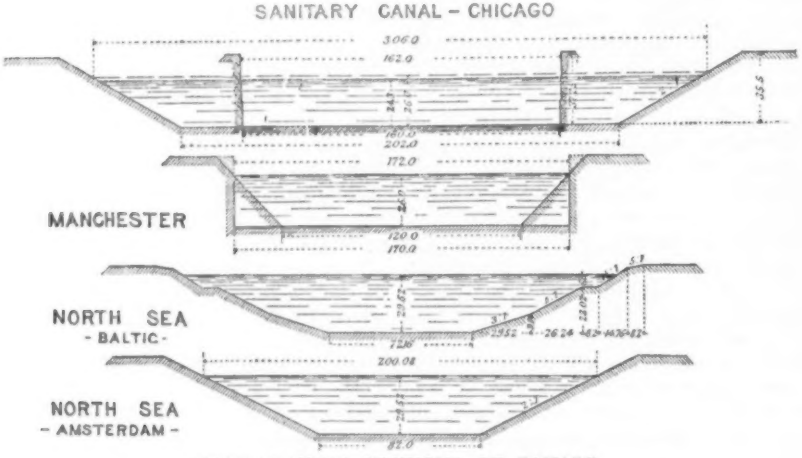
"The work was begun Sept. 3, 1892, and the contracts for completion expire April 30, 1896. The amount of excavation involved is as follows in cubic yards:

	Glacial drift.	Solid rock.	Total.
Main channel	25,945,756	12,071,668	38,017,424
River diversion	1,300,900	229,175	1,530,075
Total	27,246,656	12,300,843	39,547,499

"There will also be 348,958 cu. yds. of retaining wall and 1285 cu. yds. of slope rock. Of the total excavation required, 45.43 per cent. was completed on Jan. 31, 1895. The estimated cost of work under contract is about $19,000,000, and the total estimated cost of construction, both that under contract and that to be contracted for, and including the engineering and superintendence, in round numbers is $23,875,000. The estimated cost of the completed canal, including right of way and all expenses, will be $27,303,216.

"The cross section of the sanitary canal is greater than either the Suez, the Manchester, or the North sea ship canals. The depth at low water is 22 ft., at high water 26 ft., while the mean, under ordinary conditions of the lake, will be 24 3-10 ft."

Among the various types of excavators and conveyors used in this work may be



COMPARATIVE SECTIONS OF CANALS.

mentioned the Travelling Cableway, having a 700-ft. span between two 90-ft. movable towers, and having a capacity of 600 tons each per day of 10 hours. There are twenty of these at work. In the Bridge conveyor system a steam shovel fills the cars, which are hauled up an inclined bank on the movable bridge from which they are dumped. The steam shovel capacity is 825 yds., though the conveyor could easily handle 1300. There was some trouble with the Steel Belt Conveyor through collapsing of the framework. The 22-in. Rubber Belt Conveyor, with an average capacity of 777½ yds. per 10

hours and a maximum of 1100 yds., was charged by a steam shovel and discharged from a bridge. The material is clay and sand. In the Desplaines river black muck from 2 to 20 ft. in depth was excavated with great economy by powerful hydraulic dredges.

The muck is cut out by a revolving steel cutter and drawn through "a 20-in. suction pipe into a centrifugal pump, which forces it through an 18-in. discharge pipe, sometimes a distance of 4000 ft. to a settling basin." The average capacity was 2500 cu. yds. in 10 hours, the maximum, 7000 yds. in 12 hours. The pump had a capacity of 17,000 gallons per minute, and the water carried 8 per cent. of solid matter.

Double Inclines, Half-Loop and Single Loop Inclines, Tipple Inclines, methods of building retaining walls having 2 ft. batter and 4 ft. wide at top, and the method of using the Self-Filling Scraper, are fully described. This work is very interesting as representing a large variety of excavation methods operating at their highest efficiency.

Strength of Bridge and Trestle Timbers.

THE committee of the Association of Railway Superintendents of Bridges and Buildings made a report at the recent New Orleans meeting, of which the following is an abstract. The conclusions are condensed from a report in the *Engineering News* (Oct. 24), and are here given.

(1.) Timber of the same species varies in quality so much that limits of strength are hard to define. (2.) Local timber classification is often inaccurate and confusing. (3.) Variations in strength are generally directly proportional to the density or weight of timber. (4.) Seasoned lumber is stronger than green lumber. (5.) Structures should be designed for moderately seasoned lumber. (6.) Age or use does not affect the strength of timber, unless decayed or checked. (7.) The elastic limit is not well defined. (8.) Knots reduce the strength of timber. (9.) Heart wood is liable to season-checking and failure by longitudinal shearing. (10.) Top-logs are usually not so strong as butt-logs. (11.) Compressive tests give the most uniform results, and should be employed for comparisons. (12.) When the length exceeds twenty times the least cross section, the column fails by "buckling." Long column formulas must be employed where the length exceeds fifteen times the least diameter. (13.) Eccentric loads and uneven end-bearings are more hurtful than is usually supposed. (14.) A long column composed of several sticks has the same ultimate strength as each component stick would have, if considered

AVERAGE SAFE ALLOWABLE WORKING UNIT STRESSES IN LBS. PER SQ. IN.

Kind of Timber.	Tension.		Compression.			Transverse Rupture.		Shearing	
			With grain.						
	With grain.	Across grain.	End bearing.	Columns under 15 diams.	Across grain	Extreme fiber stress.	Modulus of elasticity.	With grain	Across grain.
Factor of safety	Ten.	Ten.	Five.	Five.	Four.	Six.	Two.	Four.	Four.
White oak	1,000	200	1,400	900	500	1,000	550,000	200	1,000
White pine	700	50	1,100	700	200	700	500,000	100	500
Southern, Long-leaf, or Georgia yellow pine	1,200	60	1,600	1,000	350	1,200	850,000	150	1,250
Douglas, Oregon & Washington fir or pine:									
Yellow fir	1,200	....	1,600	1,200	300	1,100	700,000	150	....
Red fir	1,000	....	....	....	....	800	.....	....	....
N'th'rn or Short-leaf yellow pine	900	50	1,200	800	250	1,000	600,000	100	1,000
Red pine	900	50	1,200	800	200	800	600,000	....	....
Norway pine	800	..	1,200	800	200	700	600,000	....	....
Canadian (Ottawa) white pine	1,000	....	....	1,000	....	....	....	100	....
Canadian (Ontario) red pine	1,000	....	....	1,000	....	800	700,000	100	....
Spruce and Eastern fir	800	50	1,200	800	200	700	600,000	100	750
Hemlock	600	....	....	800	150	600	450,000	100	600
Cypress	600	....	1,200	800	200	800	450,000	....	....
Cedar	800	....	1,200	800	200	800	350,000	....	400
Chestnut	900	....	....	1,000	250	800	500,000	150	400
California redwood	700	....	....	800	200	750	350,000	100	....
California spruce	....	....	....	800	....	800	600,000	....	....

as a column by itself. (15.) Bearing areas should be so proportioned as to prevent indenting or crushing the fibres, and thus increasing the liability to decay.

The table presented contains figures recommended by the committee for the average allowable unit stresses used in working designs.

Construction Standards.

SOME of the most useful contributions to technical information come from men actually engaged in the practical work of which they speak. Of this character is an address by Mr. C. C. Schneider, chief engineer of the Pencoyd Iron Works, on "Details of Construction of Engineering Structures," which is reprinted by *The Engineering Record* (Oct. 26). After presenting a vast amount of practical suggestions and going into minute details in the requirements necessary for good drawings in structural work, he concludes: "In order to have some uniformity in the shop work, it is necessary to have a system of standards, which are used by every engineer in the office to assist him in making detail and shop drawings. This system of standards, however, should not be carried so far as to include details of construction, but should only cover such general points as the rivet spacing for different shapes and sizes of rivets, the sizes of eyebars, pins, nuts, lattice bars, clevises, turnbuckles, upset ends of rods, beam connections, etc. Standards have the advantage, besides that, of making the work more uniform, of relieving the draughtsman of considering these little points every time he makes a drawing, which would take a good deal of his time. These standards have generally been worked out by experienced men for the benefit of those employed in the office, and will, therefore, be productive of better results than if everyone, and more particularly those of little experience, would decide upon the dimensions, etc., which are given by the standards. This system of standards has been in some cases abused by including details of construction. This I consider bad practice, as it prevents the designer from exercising his own judgment and ability and from making improvements. The designer simply becomes a machine which manufactures designs. I know of cases where complete standards for constructive details were marked out for all the details of railroad bridges of different spans, under the supervision of the engineer in charge of the office, thus making machines of his assistants, who were simply manufacturing designs by joining together a lot of ill-advised details, the results of which consisted in a lot of structural monstrosities, samples of which are yet on exhibition on some of our railroads.

"In concluding my remarks on drawings for structural work, I would take the liberty to make a suggestion, referring to the instruction of students in the way of making drawings somewhat similar to the way they are made in actual practice. Instead of stretching a piece of paper on a drawing-board, let it be simply tacked down with thumb-tacks, make the drawing in pencil, and then make a tracing of the same. This will give the student an opportunity to get some practice in making tracings, which would be of some advantage to him when he enters practical life in the profession."

Tests of Commercial Timbers.

THE Association of Railway Superintendents of Bridges and Buildings, at their fifth annual convention in New Orleans (Oct. 15), passed a series of resolutions commending very highly the work of the government on forestry. One of these resolutions is stated thus: "Resolved, further that we ask our representatives in congress to make liberal appropriations for the continuance and more rapid advance of this work, in order to secure, as quickly as possible, the much-needed information, believing that the government alone is in a position to secure it, and that it is true economy to provide it without delay." This shows that both the department and the association mentioned are alive to the times, the first in giving information which is needed, and the second in knowing "a good thing when they saw it."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Bridges.

2005. The New Terminals of the Brooklyn Bridge. Ill. (A brief account of the recen changes made at the terminals of the Brooklyn Bridge). Sci Am-Oct. 19. 800 w.

2112. Strength of Bridge and Trestle Timbers. (Report of a committee of the Am. Asso. of R. R. Supts., Walter G. Berg, Chairman. Gives a great deal of valuable data with a recommendation to the profession that the average units for the ultimate breaking stresses of principal timbers used in bridge and trestle building—derived from the investigation and presented in tabular form for different materials—be generally adopted). Ry Rev-Oct. 19. 2000 w.

2151. Suspension Bridges. Leffert L. Buck (Extracts from a lecture, reprinted from the *Polytechnic*. A very readable article discussing the advantages and disadvantages of such suspended structures). R R Gaz-Oct. 25. Serial. 1st part. 2500 w.

*2166. The Superstructure of Railway Bridges. J. F. Conradi (Advocating the adoption of standard regulations respecting live loads, and submitting some standard designs for railway bridges). Eng, Lond-Oct. 18. Serial. 1st part. 3500 w.

*2401. The Design of English Railway Bridges of Moderate Span. Walter Beer (The author says more attention should be paid to "rolling" and "dead" loads, to varying unit stress, and to accessibility of all parts. The article takes up in turn (1) determinations of "live" and "dead" loads; (2) dimensioning; (3) examples of railway bridges, and (4) specifications, tests, etc.). Eng Rev, Lond-Oct. 21. 1700 w.

Canals, Rivers and Harbors.

1923. Prospects for a Ship Canal from the Great Lakes to the Hudson. Thomas C. Clarke (A paper read at the first annual meeting of the International Deep Waterways Asso. The discussion in full with appendix. The best paper read before the Cincinnati convention thus far. Special attention to the question of economy. Will it pay?). Eng News-Oct. 10. 4000 w.

1924. A Deep Waterway from the Great Lakes to the Ocean (Editorial consideration of the various views with comments upon the difficulties attending the construction and operation of a ship canal). Eng News-Oct. 10. 2400 w.

1938. The Isthmian Canal. C. F. Z. Caracristi (Some interesting statements regarding the Panama and Nicaraguan routes. Their international bearings and engineering features discussed. Mfr's Rec-Oct. 11. 3000 w.

*1946. The Ship Canal from Bruges to Heyst. From the *London Times* (A brief account of the work to be carried out, and of various opinions, pro and con, as to its value to the city. It will cost about 39,000,000 francs). Arch, Lond-Oct. 4. 1000 w.

*1973. Weirs in Rivers. F. G. M. Stoney (The effect of fixed and movable weirs in flood time; four illustrations of Stoney's system of using an iron sluice girder). Eng, Lond-Oct. 4. 2200 w.

*1975. The Port of Rouen and Inland Waterways (The effect of canal and river navigation on inland commerce, with some interesting figures of rates and a traffic diagram of French waterways). Eng, Lond-Oct. 4. 1800 w.

*2048. The Corinth Canal. Henry E. P. Cottrell (Giving the advantages of the various ship canals of the second class, proposed and completed, with a historical and detailed description of the Corinth canal, which connects the Ionian Sea and the Archipelago, effecting a saving of 120 to 180 miles to navigation. Map). Engng-Oct. 4. Serial. 1st part. 1500 w.

2054. Modern Methods of Canal Excavation. Isham Randolph (Abstract. A historical review with a statement of the comparative merits of the various shovel excavators, conveyors, etc., used in the excavation of the Chicago drainage canal, by the chief engineer in charge of the work. Read at the Cleveland Deep Waterways Convention). Eng Rec-Oct. 12. Serial. 1st part. 2000 w.

2090. The Seattle Canal and Land Reclamation Enterprise. Ill. (A seven million dollar enterprise, requiring five years for completion, consisting of waterways and canals connecting Elliott Bay, Wash., with Lake Washington, a distance of 20,785 feet. An interesting article). Eng Rec-Oct. 19. 2000 w.

2093. Flood Protection at Williamsport, Pa. (Report of Maj. Charles W. Raymond, U. S. Corps of Engineers, and Mr. L. Y. Schermerhorn, recommending the removal of a dam above the city, and of some R. R. bridge approach embankments, removing island and pier obstructions in the channel, and building of embankments to confine the water to the channel, and also the use of a pumping plant to drain flooded areas). Eng Rec-Oct. 19. 3800 w.

*2247. New Harbor Works at Palermo (A report from E. M. de Garston furnishing particulars regarding public works about to be carried out in Palermo, including proposed dry dock, jetty, further quay frontage, and other harbor improvements). Bd of Tr Jour-Oct. 1400 w.

*2326. Improvements in the Ports of Ipswich and Harwich (The shortening and deepening of the estuary channels allowing vessels of 19½ feet draught to come up to the dock). Eng, Lond-Oct. 25. 1800 w.

2394. The Proposed Improvement of the New York State Canals (Editorial discussion of

the measure before New York voters to appropriate $9,000,000 of state money to the deepening and improvement of the Erie canal. The conclusion arrived at is, that the proposed improvements would be a wise measure). Eng News-Oct. 31. 2900 w.

2456. Hydraulic Dredging Steamer "Gen-C. B. Comstock." Ill. (A 177×35½×16 foot boat having two centrifugal pumps with a capacity for sand of 1000 cu. yds. per hour, two hopper reservoirs holding 500 cu. yds., 15-in. suction and discharge pipes; self-propelling and steam steering; and altogether a quick working dredge. It is used to deepen Galveston harbor, Texas). Eng News-Nov. 7. 1500 w.

Hydraulics.

2237. Concrete Foot Wall, Queen Lane Reservoir Repairs, Philadelphia. Ill. (Brief mention of the details of a contract to repair a leaky reservoir for Philadelphia water-works. These leaks are to be prevented by foot-walls reaching to rock bottom, placed at the bottom of the inside slope, and, if possible, by the use of an asphalt lining). Eng News-Oct. 24. 450 w.

2396. A Peculiar Accident to the Settling Basin at St. Louis, Mo. Ill. (The water works settling basin is confined by a 15-ft. high wall of cement masonry, which bridged a washout under it, a distance of 61 feet, without sign of fracture. The water penetrated the bottom consisting of 18 inches of puddle covered by 6 inches of concrete, raising the bottom and washing out the underlying sand). Eng News-Oct. 31. 450 w.

Irrigation.

*2044. The Irrigation Problem in California. W. S. Green (A very general talk on the political influence brought to bear on irrigation schemes in California). Overland Monthly-Oct. 2200 w.

*2320. Underflow as Related to Irrigation. H. V. Hinckley (An important problem of the western states fully discussed. A consideration of the public importance of the underflow and the necessity for understanding it). Eng Mag-Oct. 3500 w.

Miscellany.

1969. Chemical Preservation of Timber. (Specification in full as used by a prominent Florida creosoting company, giving the conditions regarded as essential). Ry Age-Oct. 11. 2400 w.

*1971. The Brighton Dyke Aerial Ropeway (Description of two suspended cable ropeways to carry passengers; illustrated by sketches and section of structure, with details of mechanism; oil engine motive power). Eng, Lond-Oct. 4. 800 w.

*2032. Stopping a Troublesome Slide at a Summit Tunnel. John D. Isaacs (Illustrated description of tunnel and retaining wall of concrete monolith on the Santa Cruz Division of the So. Pacific R. R., with discussion). Jour Asso of Eng Soc-Sept. 3300 w.

†2182. The Maintenance of English Roads. Sidney M. Johnson (The system by which English roads are maintained under County Councils with cost, and discussion). Eng Soc of the School of Prac Sci-No. 8. 7000 w.

†2184. The Country Roads of Ontario. John A. Duff (Showing how the English system of maintaining roads is applicable to Ontario, with estimates of cost. A comprehensive paper going fully into the subject, with discussion). Eng Soc of the School of Prac Sci-No. 8. 9500 w.

†2189. On the Use of Asphaltum in Engineering Construction. Frank N. Speller (Historical sketch followed by its application to reservoirs, masonry, paving, etc.). Eng Soc of School of Prac Sci-No. 8. 6500 w.

*2212. Temperley's Patent Transporter. Ill. (A single rope conveyor with I beam track and automatic traveller for inside or outside work, adaptable for unloading vessels or cars). Min Jour-Oct. 19. 1200 w.

2288. Testing Pacific Coast Timber (Results obtained with Humboldt redwood showing the strength per sq. in. to be—tension 6521; compression 4385; compression transverse, 976; longitudinal shear, 548). Min & Sci Pr-Oct. 26. 600 w.

*2328. The Gigantic Wheel (Description of method employed in erecting a large wheel of the Ferris type at Earls Court in connection with the Empire of India exhibition. Illustrated by view and drawings of details). Eng, Lond-Oct. 25. 1600 w.

2353. The "Monobar" Conveyor Chain. Ill. (A gear driven flight conveyor in which pulsating motion is made uniform by varying the diameter of the pitch line in the driving gear wheel). Am Eng & R R Jour-Nov. 1 800 w.

†2370. Tests of Cement Mortar Mixed With Various Kinds of Sand. Ill. A. S. Cooper (Experiments made to determine whether fine sea sand was superior to coarse sand for cement mortar. The coarse sands, over $\frac{1}{32}$ in. diameter, are found better. In finer sands, under $\frac{1}{60}$ in. diameter, there was no appreciable difference). Jour Fr Inst. Nov. 2500 w.

2391. Erecting Viaduct Trusses Without False Work. Ill. (The floor of the viaduct is 80 to 100 ft. above ground, and the truss spans of the Pratt type vary from 108 to 162 ft. in length. The trusses were put together on the ground and hoisted into place on the four column towers). Eng News-Oct. 31. 600 w.

2395. A Cement Testing Machine and Concrete Mixing Plant. Ill. (The single beam cement tester is weighted by an inflow of water, measured by a gauge on the exterior of the vessel. The cement is mixed with sand in a "tumbler" consisting of a cubical box having the shaft fastened to trunnions fixed at diagonally opposite corners). Eng News-Oct. 31. 400 w.

2455. Beaver Valley Land and Irrigation Co.'s System in Southwestern Utah. W. P. Hardesty (A reservoir and dam for storing water for irrigation purposes. The dam will be 1800 ft. long, less than 8-ft. high for 1000 ft. and 14 and 25 ft. for the remainder of its length. About 50 sq. miles will be watered, the water rights being $10 per acre and 50 cts. annually for maintenance). Eng News-Nov. 7. 1500 w.

DOMESTIC ENGINEERING

Ventilation of Gas-Lighted Rooms.

DEALING with this subject in a paper read before the recent convention of the American Gas Light Association (*Progressive Age*, Nov. 1), Mr. Irvin Butterworth corrects several current errors relating to ventilation.

"When Holmes's deacon set about building his famous 'one-hoss shay,' he uttered a piece of invincible logic that is just as applicable to the gas business as it is to chaise-building when he said that 'the weakest spot must stand the strain,' and that the way to fix it is 'to make that place as strong as the rest.'

"Every good thing—even the gas business—has its 'weakest spot,' and gas men should look their business squarely and honestly in the face, locate this spot, and immediately proceed to do what they can toward making it 'as strong as the rest.'

"We do not make a very damaging admission when we confess that the electric light man's strongest 'talking point' against gas—in fact, practically his only one—is that its use for illumination is attended with more or less generation of heat and vitiation of the atmosphere. Let us frankly admit this, but forthwith set about, not only to prevent his making more of the point than the facts warrant, but also to reduce its present actual standing ground to still smaller limits. Much can be done in both directions. We can determine and publish to the world just how much of fallacy there is in the popular impression that electric lighting is more healthful than gas lighting, and see to it that its superiority in this respect is not exaggerated to our detriment; and we can courageously grapple with the difficult and complicated problem of the ventilation of gas-lighted rooms, with excellent chances, in my opinion, of securing good practical results that will aid materially in maintaining and increasing the popularity of gas lighting."

Mr. Butterworth charges that the subject of ventilating gas-lighted rooms has been neglected both in American gas journals and by gas engineers, and he delicately hints that gas men may have despaired of any further advance in this direction, and "tacitly agreed to maintain a discreet silence about it." He then reviews the line of inventions which have represented efforts to remove the products of combustion of gas lights, commencing with self-ventilating burners, of which the first one of all is credited to Prof. Faraday. They are objectionable as being unsightly, expensive, and troublesome. They absorb light, radiate heat, are affected by down drafts through their main tubes, hoods, etc., and do very little toward ventilating the room as a whole. But the ventilating gas lamps of the Siemens-Lungren type, which are of comparatively recent origin, are declared to be free from most of the objections named.

"There is no question whatever but that these ventilating gas lamps furnish an absolutely perfect means of simultaneously lighting and ventilating rooms and incidentally preventing the blackening of ceilings. They have received the enthusiastic praise of the most eminent gas engineers and scientists. With two such lamps Mr. Bransept extracted 5000 ft. of air per hour from a room, the temperature of which increased only 4 deg. F. after the lights had burned for 4 hours. Prof. Lewes extracted 5000 ft. of air per hour with one lamp, and also found that the radiant heat from such a lamp only raised the temperature at a point 5 ft. below the lamp, only 2 deg. F.; while Mr. Simmance secured ventilation so efficient that the temperature increased only 1 deg. F. after hours of lighting; and he goes so far as to say that such lamps can be made to carry off three thousand times as much air as there is gas consumed. A lamp burning 16 ft. per hour would therefore be able to extract 48,000 ft. of air per hour. Practical tests of these lamps have repeatedly and abundantly demonstrated

that the same gas that will adequately light a room will at the same time adequately ventilate it, and that the lighting and the ventilating are both better done than is possible when an electric light is used."

It is asserted that the cost of these lamps is the chief cause that has prevented their wide adoption for public halls, stores, etc., but it is also admitted that they are not ornamental, that they are not adapted to use in dwellings, etc., and that, although they are mechanically a complete success, something simple and more easily applied must be sought. Mr. Butterworth thinks a special flue running at the side of a chimney or up through the center of a building, and ventilating registers near to or in the ceiling, would meet all the requirements of the case. This has been tried over and over again. It takes away very thoroughly the products of gas combustion. But, as a matter of fact, an unventilated room lighted by electricity is nearly or quite as unwholesome as though it were lighted by gas. The discomfort of heat is admittedly greater on the side of gas, but in a room ventilated from apertures near the ceiling the heat of the gas becomes an active agent in effecting the removal of vitiated air, thus giving to gas a superior advantage. The article fully exposes the following alleged popular errors: (1) That electric lighting is more healthful than gas lighting; (2) that carbon dioxid is extremely dangerous; and (3) that the quantity of carbon dioxid present in a gas lighted room is of itself a measure of the impurity of the atmosphere therein.

How To Reduce Gas Bills.

THE *Journal of Gas Lighting* gives advice on this subject, taking as a text an article in the *Daily News* (London). As the advice is good, we will give our readers (many of whom doubtless grumble at the regularly-presented, inevitable, and sometimes exorbitant demands of the gas companies) an abstract of it. How many of them ever think, when the bills seem unduly large, that the fault most likely lies at their own door, and that in nine of every ten cases of complaint, and probably a much greater proportion, the gas companies have charged for exactly the gas that has been consumed *and wasted*. For a great deal of gas is wasted in unsuspected ways by consumers. Happily, as our contemporary shows, it is not so much technical knowledge that the average gas consumer needs for keeping his bills within bounds, as the application of a little common sense and care for his own interest.

"It is, we suppose, inevitable that a popular writer on the subject of domestic gas consumption should have his little joke about the tricky and mendacious meter. Gas officials know that there is another side to this picture, and also that mendacity and intention to deceive are not more conspicuous in the much-maligned meter than they are in some of those members of his household to whom the consumer is in the habit of referring for information as to how much gas is used in the house when his back is turned, and in regions to which the head of the household rarely penetrates." The *Daily News* article lays due stress upon considerations of the latter order, and wisely reminds the householder "that now and henceforward is the proper time to look after gas burners unnecessarily or improperly used, and that it will be too late to do so when the bill for the Christmas quarter comes in. A wasteful habit of lighting the gas in bed-rooms and in little-used passages at night-fall and leaving the flames burning at the full until the house is shut up for the night is easily acquired by young people and servants about this season of the year, when long evenings are yet a novelty. Unless this extravagance is checked betimes by some person in authority, an enormous quantity of gas will be passed through the meter without anybody suspecting the fact; and then, when the bill comes in, there is an explosion—though not of coal gas; and, of course, nobody knows how or why so much gas has been consumed."

The writer mentions with favor the growing employment of gas-burners with flash-lights, which enable the flame to be turned on or off at will, thus imparting to gas one of the most admired advantages of incandescent electric lighting. He also observes with truth that, next to the supervision of servants and the wants of out-

of the-way burners, the matter of pressure is probably the most important consideration and the one most generally overlooked. He proceeds to give some perfectly correct directions as to the proper way to burn gas by means of open flames, so as to get the full lighting advantage from it, and points out the wastefulness of consuming gas at too great or too little pressure. Curiously enough, says *The Journal of Gas Lighting*, "he just stops short of giving the full practical value to his advice by recommending the use of governor burners. It is true, he declares that, unfortunately, the photometer does not form any part of the appliances of an ordinary household, or gas consumers would soon realize pretty clearly that some form of regulator is indispensable, if they wish to get full value for the gas they pay for. But he omits to mention that, for a few pence each, there are regulator burners to be had, any pattern of which will save its cost many times over in the course of a winter's quarter, as compared with the waste of an unregulated burner."

It may be suggested that distributing engineers occasionally, from want of thought, bring their employers into disrepute by failing to notify consumers when considerable alterations are effected in the ruling pressures of a particular district. Every year, in the ordinary way, districts discovered to be getting an insufficient supply are provided with larger mains, and trunk mains are run to distant points with the praiseworthy object of equalizing pressures. This is all very right and proper. But it sometimes happens that consumers who have become habituated to low-pressure conditions suddenly get the offer of a largely, increased supply as the result of main-laying operations of which they have been kept in profound ignorance. In such cases they may or may not notice that their gas is better than it used to be. But, when the next quarter's bill comes to hand, they are sure to be startled at its unprecedented magnitude. The gas manager rubs his hands at the increased consumption that has rewarded his improvements in distribution. But the consumer rages, and is not to be pacified by any retaliatory measures short of ordering out all the gas-stoves and gas-fires in his place, and perhaps investing in oil-lamps as well. Much of this might be obviated by notifying the consumers betimes of what to be prepared for. At any rate, if, after being forewarned, he is not forearmed, the fault is his own.

Fires Caused by Heating Pipes.

IT may be stated as a general fact that substances whose physical condition is such that they absorb oxygen rapidly from the surrounding atmosphere have their tendency to spontaneous combustion increased by proximity to, or contact with, heated surfaces. Spontaneous combustion in such substances takes place when their heating (the result of chemical reaction) reaches the point of ignition. The smaller the mass, the more readily will it part with the heat so generated, and hence it may occur that small quantities of oily waste, etc., which in a larger quantity would ignite, may heat, but never quite reach the temperature of ignition. It is easily conceivable of a mass which would heat spontaneously from ordinary temperature almost to the temperature of ignition that, starting to heat from a higher temperature, it might actually reach the point of ignition and burst into flame. The initial higher temperature requisite to effect such a result may be sometimes derived from a steam or hot-water pipe; hence caution should be observed in disposing of such materials with reference to heating appliances. That such caution should extend to some substances in domestic use, not generally suspected of being dangerous, is apparent from facts stated in an article in *Heating and Ventilation* (Oct. 15).

The article quotes letters—one from Mr. Phillippe Douval, chief engineer of the fire department of Quebec, and one from the city engineer of Quebec—to fortify the opinion that even low steam pressure heating pipes and hot-water pipes may sometimes originate fires in this way. The engineer referred to appears to have made some valuable observations upon this subject. He writes as follows:

"I have to remind you that it is only a few years ago—a fact of which I believe I

informed you at the time—that, while I occupied the house, 54 St. Louis street, now tenanted by Dr. Beaupre, some light, cotton, children's under-clothing laid on the radiators to dry in one of the upper stories was brought to me in astonishment by my wife, and found to be scorched absolutely, as if by an overheated smoothing iron. This was during soft weather, and therefore there was nothing to rob the heaters of their super-abundant heat, due to a very hot fire at the time. This is a result which most persons are apt to doubt and even disbelieve; the idea being that the heat of boiling water or ordinary steam —that is, steam produced under ordinary atmospheric pressure—can produce no such effect; and, in truth, such a temperature cannot do so, though in course of time even this will dry some woods to an extent to almost char them and reduce them to the state of lignite, making them porous and of loose grain or fibre and ready to take fire from the merest spark which, under other circumstances, would die out ere it had time to produce any effect. But the fact is that, just as at an elevation above sea level you cannot, owing to the decreased pressure of the atmosphere, get a cup of hot tea unless boiled in a close vessel, in the same way, in these hot-water plants, the temperature goes far beyond the supposed 212 deg. F., due to the water being confined and under more than atmospheric pressure. In fact, in an ordinary one-story house and attic with heaters in the basement, and where the height to the cistern or reservoir level may be 30 ft., the pressure will be two atmospheres, and the corresponding temperature of the water 256 deg., instead of only 212 deg. But in a three-, four-, or five-story house with attic and heater in basement the pressure on the water in the boiler will reach three atmospheres, and even four or more for greater altitudes, and the temperatures will increase to 274 deg., 292 deg., and so on. Again, the overflow cistern, or pipe leading to it, will sometimes get out of order, or become choked or impeded in such a way that, though the height may not be greater, the pressure may be enhanced to almost any extent, and the temperature may rise to 500 deg. or more, and become capable of quickly charring the softer and resinous woods, thus robbing them of their oxygen, when, on cooling again, they take in oxygen so quick as to take fire."

Mr. Douval, in his letter, attributed a fire which occurred a few years ago in the Quebec post-office building to the placing of a lot of canvas mailbags on a hot-water heating pipe. The opinion was questioned at the time, but recently he has found confirmation of it in a fire which occurred in a house on St. Valier street, which was caused by a hot-water pipe passing through a deafening of saw-dust in a wooden ceiling.

Removing Air From Steam Coils.

A CORRESPONDENT of *American Machinist* recommends for the sure and automatic removal of air from an extensive heating plant the employment of a steam ejector, which he regards as the only positive means of effecting the object. He describes the arrangement as follows:

"To each coil or radiator, instead of the usual pet cock, attach an adjustable automatic air valve by a piece of ⅛-in. pipe about 3 or 4 in. long, connected to the air valves by a ¼-in. pipe to a ½-in. air main, which is to follow the general course of the return main; run this air main to the boiler or the engine room, at which point attach an ejector operated by live steam from the boiler; run the outlet pipe from the ejector outdoors, either directly, or through the main exhaust pipe, to the roof, connecting in the latter outside of the back-pressure valve. Pipe ½-in. inside diameter is large enough throughout the building for the air main for ordinary cases, say, up to 5000 sq. ft. of pipe surface; above that amount of surface, the air main in basement may be ¾-in. pipe to the ejector. All of the air piping must be air-tight. A No. 1 ejector will take care of 1000 sq. ft., and a No. 2 ejector will take care of 5000 sq. ft. of pipe surface. Where more surface is to be provided for, the air system should be divided into units of about 5000 sq. ft. each. On the air main, both to and from the ejector,

place a swing check valve, and on the steam supply pipe use a globe valve, these valves to be of the sizes called for by the ejector's connections, and close to it.

"A small combination steam and vacuum gage placed in the heating main convenient to the eye of the engineer will inform him of the condition of pressure in the heating system.

"By the use of the above, the air will be expelled as rapidly as accumulated by the process of condensation, therefore relieving the engine of back pressure and maintaining the heating surface in lively working condition. This method of expelling the air from heating systems is illustrated by Pictet, in his 'Treatise on Heat,' published in 1860, as having been done by M. Pelletan, and is therefore common property."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Domestic Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Heating and Ventilation.

*2050. The Heating Value of Coal Gas (Discusses the enormous extension of the use of coal gas for domestic heating and cooking, and suggests legislative restrictions regulating its quality, sale and distribution for these and analogous purposes). Engng-Oct. 4. 1200 w.

2055. The Carnegie Building, Pittsburgh, Pa Ill. (Description of the indirect heating and ventilating system for the lower floors and of the power plant). Eng Rec-Oct. 12. Serial. 1st part. 1800 w.

2099. Electric Heating. J. Chester Wilson (Read before the Eng 's Club of Philadelphia and published in the Proceedings. States principles underlying the production of heat by electricity; discusses the present activity in invention in electrical devices; reviews various estimates of economy, and the various applications of electric heating in the industries, to date). Am Arch-Oct. 19. 2200 w.

2102. A Hot Water Residence Heating Plant (Illustrated description of a hot-water heating and ventilating apparatus for a residence in a much exposed position). Heat & Ven-Oct. 15. 900 w.

2103. The Capacity of Fans for the Movement of Air Against Pressure. H Eisert (An able discussion of practical value with formulæ for computing capacities of fans for special conditions). Heat & Ven-Oct. 15. 2000 w.

2145. Removing the Air from Steam-Heating Coils. H. E. (Describes a combination of an ejector with the air-pipes of a heating system for evacuating the air). Am Mach-Oct. 24. 400 w.

*2230. Heating by Electricity. Ill. (The methods employed; the bad effects resulting from the use of copper; the best kind of wire to employ; other practical points mostly relating to car heating). Mach-Oct. 15. 500 w.

2307. The Ventilation of Gas Lighted Rooms. Irvin Butterworth (An able argument is herein made in support of the proposition that rooms electrically lighted require ventilation as much or even more than gas-lighted apartments, the impure air in electrically lighted rooms accumulating more in the lower part of the space than in gas-lighted rooms, on account of the lack of upward currents produced by the heat of gas-burners. It is also maintained that gas-lights do not, as a rule, vitiate the air in rooms where they are used to anything like the extent which has been and is commonly attributed to them). Pro Age-Nov. 1. 3800 w.

2368. Heating and Ventilating a Thirteen-Room School (Full description with plans and details of plant in the George St. school, New Haven, Conn. An instructive study in heating and ventilating schools). Eng Rec-Nov. 2. 3300 w.

Landscape Gardening.

2255. Special Attractions in City Parks (Editorial reply to a correspondent who advocates the introduction into city parks of all kinds of attractions that will draw the people into the fresh air). Gar & For-Oct 30. 1600 w.

2256. The Floating Gardens of Mexico. Charles H. Coe (Description of the gardens of the past and of the present day, with suggestions regarding their origin). Gar & For-Oct. 30. 1300 w.

Plumbing and Gas Fitting.

*2065. Practical Plumbing. Ill. (It is the writer's intention to give details and methods of doing actual work—many subjects which have not been practically dealt with). Ill Car & Build-Oct. 11. Serial. 1st part. 3000 w.

*2425. On the Flow of Gas in Pipes. Arthur H. Crump (A new formula for computing the number of gas lights which a pipe can carry, and conversely the size of pipe suitable for any given number of lights). Jour Gas Lgt-Oct. 29. 500 w.

Miscellany

2104. Fire Caused by Radiator (Hot water pipes may under certain conditions, not unusual, become a source of fire risk. Conditions involving such risks are stated). Heat & Ven-Oct 15. 500 w.

*2137. Good Advice for Gas Consumers (Editorial. Economy in gas consumption. How gas bills can be kept low). Jour Gas Lgt-Oct. 15. 800 w.

*2402. Separation and Storage of Rain Water (Illustrates and describes a new apparatus for purifying rain water collected from roofs). Eng Rev, Lond-Oct. 21. 800 w.

We supply copies of these articles. See introductory.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading and Domestic Engineering.

The Question of Higher Voltage.

THE change from lower to higher voltage in low-pressure plants has recently attracted much attention from the fact that in one or two instances in England this change has been made, and it is now proposed to raise the voltage of still another plant from 110 to 220. This change has been made under the advice of an electrician acknowledged to be an expert, and yet, as this change relates especially to lamps, *The Journal of Gas Lighting* (Oct. 8) questions its advisability, or, at least, points out difficulties and risks attending such changes that ought to be very carefully considered in advance. An abstract of what it says follows, from which it appears that the effects of this sort of change reach a good way.

The principal question arising in connection with the alteration of pressure refers to the lamps. Hitherto lamp manufacturers have been accustomed to work to the lower standard of from 100 to 110 volts; and it is admitted that an altogether new make of lamp will be needed to meet the fresh conditions of the service. Mr. Baynes, the electrician referred to, declares that there is no difficulty in the matter, since he has had 220-volt lamps in use for 18 months, presumably at Bradford; and he further states that 8 candle lamps at 230 volts are in the market, and a high-voltage lamp of even 6 c. p. is offered. Professor J. A. Fleming has given a qualified assent to the change; but he thinks that, if the higher voltage is to become general, domestic fittings will have to be much more severely tested and inspected than has been customary. Mr. Baynes concedes the necessity of very careful inspection and testing; but he observes that this is an essential point in any well-regulated central station, and applies to any system. This is doubtless the case. But past experience has not shown that the St. Pancras installation stands particularly well in this respect; and captious critics might inquire how much more sodium the vestry expect to make in their underground conduits under the new conditions. So far as the cardinal point of the safety of users of the new high-pressure service is concerned, it is stated that there is no more risk of getting a dangerous, or even painful, shock from a 220-volt service than from one carrying half the voltage, a tingling sensation being the utmost that would be felt if two terminals were connected through the skin. Time will elucidate this question. But meanwhile it is clear enough that the changes in the higher voltage are all in the interest of those central-station undertakings that are committed to the low-pressure principle of electric distribution. So far it is a concession to the high-pressure school, which has all along contended that no system in which the mains are restricted to carry only the low voltage hitherto employed can be commercially successful over anything like an extensive area. It means burying a copper mine to command even such a compact district as that of the St. James's and Pall Mall Company; and, of course, doubling the voltage renders this copper competent to earn much more money.

There is no reason to suppose that consumers will care whether they are supplied at 110 or 200 volts, so long as they assured that their fittings will stand. But this is certainly not a time when they could be expected to incur any extra expense for adapting their fittings to a change made wholly in the interests of the suppliers. If, moreover, there is any real difficulty in procuring, at no greater cost, low-power incandescent lamps of the new pattern, the suppliers may well lose as much as they can hope to save by the new system of supply. Electricians themselves seem to hold that much depends upon the

possibility of satisfying their consumers with the 8 candle lamp which has been adopted as the conventional unit for the enumeration of lamp connections. This gives but a low standard of lighting, and is confessedly inappropriate to shop and general commercial use. But domestic users are expected to be content with it; and they are not encouraged to patronize anything more brilliant. Now we hear of a 6 candle high-voltage lamp as being yet more suitable for lighting interiors. Whether or not the public will take kindly to this progressive degradation of their house illumination remains to be seen. We may be mistaken, but imagine that a glimmering "night light" on this scale is not the most hopeful weapon wherewith to attack the incandescent gas-burner. The incandescent electric-lamp trade is naturally perturbed at the advent of a change that bids fair to render all stocks valueless, and sets up a standard in a lamp manufacture to which only a few factories have yet learned to conform.

Mr. Baynes may be, and probably is, right when he says that the 110-volt lamp, like the original 50-volt lamp of Edison and Swan, is fated to become in time "a matter of ancient history." But the makers and sellers of the article so condemned are not likely to derive much consolation from this reflection. There was much trade in 50-volt lamps, which were proprietary goods, and curiosities rather than anything else. But the manufacture of 10- to 110-volt lamps has attained to very large proportions; and they will not be ousted without a struggle. Still, the industrial clock cannot be made to stand still at the bidding of those who are pecuniarily interested in arresting the flight of the moment. If the new system is good for anything, and anywhere, it must infallibly spread.

There is yet the question of fire risk, about which the insurance companies will have something to say. Dr. Fleming observes that with a three-wire system of distribution, charged throughout with a difference of potential of 200 volts between each side of the system (making 400 volts over all), conditions might arise that would throw the whole pressure upon house fittings originally calculated for 100 volts only; and this is something to be carefully weighed.

The English Postal Telegraph System.

AN abstract of the report of the English postmaster-general (*The Electrician*, Oct. 4) gives a good idea of the present status of the postal telegraph system in all but its financial aspects. Its public use has increased enormously since the reduction of rates to 6d. for twelve words, irrespective of distance (addresses being charged for). In the last 4 years the number of telegrams transmitted was increased from 33,000,000 to 72,000,000 (750,000,000 words).

In commenting editorially upon this remarkable increase in the use of the telegraph by the people at large, *The Electrician* says that "this does not by any means represent the aggregate amount of telegraphing crowded on to the wires in this country, where the press tariff is so low as to attract no fewer than 650,000,000 words annually. The aggregate for all other messages is only 970,000,000, so that the press alone appropriates two-fifths of the whole traffic, and, as the average length of each press message is 120 words, while that of an ordinary message is less than 15, it will be seen that the nominal total number of telegrams is no criterion of the actual work performed. Taking this fact into account, the business of the telegraphs has increased since 1870, not tenfold, as it is claimed, but more probably fifteen-fold. The number of offices has increased rather more than three-fold, and the mileage of wires less than four-fold. Instruments now number 26,000, against 4000 at the beginning of the period, but this increase may be set down largely to a vast augmentation in the number of small offices and minor circuits, not wholly to increase of work." It also avows the belief that, but for "accepting the best devices forthcoming from America, adapting them to the climatic conditions of the country, ... unremitting labor in perfecting fast speed instruments of English origin, and supplementing them with repeaters of original design" (thus en-

abling circuits having 50 words' capacity per minute to transmit 500 words per minute) "the liberal extensions of lines provided by the government for a number of years after assuming control would not have sufficed for the traffic."

The fairness with which credit is given to the United States for its share in the general advance is commendable, and not altogether characteristic of the British press in its treatment of American inventions and discoveries.

Aside from the financial status of the government, our contemporary characterizes the career of the system as splendid, both in its public utility and in its technical department. But the financial failure seems to be as conspicuous as the technical success. The report itself admits this failure. For the year ending March 31 expenditure exceeded revenue by about £154,000, which, with interest (£298,000) on the capital expenditure incurred, makes the total loss for the year about £452,000. The aggregate deficiency during 25 years of government management has been £5,859,000. The large price paid for the government purchase, the number of free railroad telegrams, and the low rate charged for press telegrams (1s. for 75 words by day and 100 words by night, while for copies only 2d. are charged for the same message), are factors in this annual loss. The report says the newspapers took advantage of these rates, no provision having been laid down that the copy must be sent to the same town as the original.

"The newspapers accordingly combined to receive from the news association messages in identical terms; and, by dividing the cost, they are enabled to get the benefit of a rate which comes nearer 2d. than 1s., the average charge being, in fact, about 4½d. per 100 words. Notwithstanding the economical arrangements which have been made for the transmission of the telegrams (5,400,000 in number, containing 650,000,000 words), the loss incurred by the post office in dealing with them is estimated to amount to £300,000 per annum.

"These unfavorable conditions have permanently affected the telegraphs. They must in any case have diminished the possibility of profit, and in the actual circumstances their effect has been to augment the loss. Moreover, new influences inimical (temporarily, if not permanently) to financial success have come into play,—namely, the reduction of the tariff in 1885, the increase in the pay of the staff, and the competition of the telephone companies for local traffic." "The proportion of the amount expended on salaries and wages to the total telegraph expenditure, which in 1881, before the revision carried out by Mr. Fawcett, stood at about 55 per cent., has since risen, as the result of that revision and the revision effected by Mr. Raikes in 1890, to about 65 per cent." The competition of the telephone will doubtless be an increasing one for years to come.

This part of the report is rather severely criticised by *The Electrician*, already quoted, which says "it is hardly an exaggeration to say that every increase of traffic is met, not by fresh demands upon the exchequer, but by the extended application of electrical devices under guidance of technical officers of the department. It is perhaps necessary to emphasize this statement, because a little further on the results are ascribed—probably by a slip of the pen—to the officers of the post office. One might with just as little truth ascribe the failure of the telegraphs financially to the engineering staff. In reality the two departments appear to be now as widely apart as ever they were, the officers in one section being all telegraphists by profession, whilst in the other they are all post-office officials. For the efficient working of the telegraph service the former are primarily responsible, and they have reason to be proud of their achievements. For the financial failure of the service the responsibility, such as it is, must always rest with the post office. We have spoken of the head of the telegraph service; but there is no such head, or, at all events, none that is at once responsible for and solicitous of the reputation of the telegraphs as distinct from that of the post office. If such an officer existed, he would not admit that the telegraphs cannot pay;

he would probably deny that they do not pay. More than one postmaster-general has declared that it is impossible to separate the accounts of the two services on anything approaching equitable lines; and, so long as the telegraph service is without any representative on the postal staff, which has the sole control of its finances, so long will the public be dissatisfied with the excuses put forward for the financial defects proclaimed year after year in the telegraphs balance sheet. It may be that the figures represent the real facts; but it would be more satisfactory if some one with an interest in the telegraph service had a hand in preparing them. In any case, supposing them to be fair and true, the responsibility must, as we have said, rest with the post office. Nobody but the post office would have so long endured the imposition of such absurdly generous press rates, or of railway free messages, or the drain upon telegraph revenue due to private telephonic enterprise."

Adequate Telephone Systems.

THE following is an abstract of a paper read by Dr. J. R. Bennett at the recent meeting of the British Association.

A country may most properly be said to be well telephoned when its smaller towns and villages enjoy telephone facilities, for the existence of a few large exchanges in the capital and chief towns does not entitle it to that distinction. For instance, France, Russia, and Portugal all possess good exchanges in their capitals, but are nevertheless badly telephoned as a whole, since their smaller towns and villages are excluded from the circle.

On the other hand, the grand duchy of Finland, under the same crown as Russia, but enjoying a different system of administration, is distinctly well telephoned. Its area exceeds that of the United Kingdom, although the greater part of its surface consists of lake, forest, and waste; its staple industries are fishing and agriculture, yet a telephone map of Finland discloses a veritable network of lines. All the towns and many of the villages possess exchanges, while the capital, Helsingfors (population 65,000), is one of the best-telephoned cities in the world. Last year there were 198 exchanges in Finland, or one to each 12,626 inhabitants. In the United Kingdom there were but 578 exchanges, or one to each 65,537 inhabitants. In proportion to its population, Finland had, therefore, more than five times as many centers of telephonic activity as the United Kingdom. Even the people of the Aland Islands, in the middle of the Baltic, find a telephone exchange so well worth paying for at the rates which are found remunerative by the exploiting company that in Mariehamn, the capital, there is an exchange telephone to every 13 inhabitants. In fact, Mariehamn is entitled to the distinction of being the best-telephoned town in the world. Another Finnish town, Viborg (population 22,344), has an exchange telephone to every 33 inhabitants, and other towns have one to 36, 37, 39, and 40.

Norway is, however, the best-telephoned country on the whole. It has a population of 2,000,000, and has little to rely upon in the world's struggle but agriculture, forestry, and fishing. Seventy per cent. of its total area is uncultivable, and another 24 per cent. is forest. It has but a half-dozen towns, the bulk of the population residing in widely-scattered villages. Yet it possesses no fewer than 256 telephone exchanges, or one exchange to each 7812 inhabitants, —more than eight and one-half times the number in the United States in proportion to population.

Sweden ranks second in the list of well-telephoned countries. Sweden possesses greater resources than Norway. It has a population of not quite 5,000,000, one-half of which is dependent on agriculture. Eighty per cent. of the people live outside the towns. A radius of 43 1-2 miles round Stockholm, equal to 5945 sq. miles, is unquestionably the best-telephoned bit of country in the world. Almost every village possesses two competing telephone exchanges, while rival systems of trunk lines place the whole of this large area in practically instantaneous communication.

Denmark, with a population of 2,250,000, chiefly agricultural, has 152 telephone exchanges,—one to every 14,369 inhabi-

tants. Switzerland, with a population of 3,000,000, has 155 telephone exchanges.

These complete the list of well-telephoned countries in continental Europe, and it is a curious aspect of the subject that only the smaller countries are comprised in it. The least favorable result in this group is 328 persons for each exchange telephone. The indifferently-telephoned countries are the German empire (excluding Bavaria and Wurtemberg), the United Kingdom, Holland, and Belgium. Of these the German empire has one telephone to every 449 inhabitants; the United Kingdom, one to every 636; Holland, one to every 643; and Belgium, one to every 700.

The badly-telephoned countries are France, with one telephone to every 1432 people; Spain, one to every 1618; Austria, one to every 1640; Italy, one to every 2530; Hungary, one to every 3169; Portugal, one to every 3371; and Russia,—least provided,—one to every 13,102.

These and other interesting statistics are given in tabulated form in Dr. Bennett's paper.

A systematic comparison is made between rates for telephone service in different countries. In Norway, Sweden, Luxembourg, Switzerland, Denmark, and Finland the rates are very low. In the imperial German post office territory rates are fair for urban subscribers, and high in small towns. The same is true of Bavaria. In Wurtemberg rates are low in cities, but with regulations tending to restrict suburban and rural intercourse. In the United Kingdom rates are high, with regulations unfavorable to development outside towns. In Holland rates are high in the three chief towns, and low elsewhere. In Belgium rates are high in the large towns, but low rates in small towns have recently been established. In the badly-telephoned countries rates are generallyhigh, except in Austria, where the rates are fair, but where subscribers pay capital cost of their installations.

Altogether Dr. Bennett's paper, printed in full in *Industries and Iron* (Sept. 20), is one of the most complete expositions of progress in European telephony that has yet appeared.

Telephone vs. Telegraph.

THE competition of the telephone with the telegraph is telling more and more upon the receipts of the telegraph lines, both in the United States and in Europe. It cannot be said that the telegraph service has materially fallen off during the last year, but it has not materially increased, and no other cause can be assigned for its not increasing than the competition of the telephone.

This view is substantially supported in an able editorial in *The Electrical Engineer* (Oct. 16), which reviews the situation from data derived from the recent statement of the Western Union Telegraph Company and also from the report of the English postmaster reviewed elsewhere in this department. That the business of the telegraph will be still further cut into by the increasing use of the telephone is argued from the following facts set forth in the editorial referred to.

"The business of the Western Union is set forth in the following exhibit:

	1895.	1894.	1893.
Miles wire...	802,651	790,792	769,001
Offices.....	21,360	21,166	21,078
Messages sent.....58,307,715		58,632,237	66,591,855
Average toll per message.	30.7c	30.5c	31.2c
Cost per message.....	23.3c	23.3c	22.7c

"It will be seen, since 1893, the company has lost a business of over eight million messages, and that nevertheless it costs nearly 1 cent more per message to handle the business it still retains. Admitting that the Postal Telegraph Co. has drawn off the difference and added a little new business of its own, it must be obvious that there is no increase of business proportionate in any degree to the increase of population, mail matter, or telephone messages. It might be said that these are dull times, but certainly not worse than 1893, and, besides, telegraphy under old conditions should have got much traffic due to the fact that the railroads were less used for intercommunication since the great panic. But there is an utter absence of elasticity. Gen. Eckert must be congratulated that, under such a state of affairs, for which he is no wise responsible, he has been able by good management to keep up

5 per cent. dividends and show a net increase in gross revenue of $365,364. But would it not be worth while to see whether the telegraph cannot be brought up to a higher ratio than one message per year per head of population?

"Turning to the English figures, we find the deficency for the year of $2,250,000.

"In other words, the English nation has lost in 7 years over $12,250,000 on its telegraphs, and would therefore appear as a telegraphic company to be in infinitely worse condition than the Western Union, which is at least solvent and paying dividends. The number of all messages in the United Kingdom was 71,589,064, a gain of 689,566; which bears out our contention that, were England, like the United States, a free user of the telephone, she would show nearly two messages per year per head, but would find the telephone catching a very large proportion of the new business. This is shown by the fact that the gain in metropolitan messages was barely 250,000, due to the sharpness of the telephonic competition."

Year.	Receipts plus nominal value of work done for other departments.	Expenditure.			Annual interest on capital.	Deficit.
		Charged to telegraph vote.	Charged to votes of other departments.	Total.		
1888-89	£2,129 965	£1,969,324	£72,037	£2,041 361	£352,787	£265,183
1889-90	2,364,099	2,179.921	99,065	2,278,986	306,016	197,690
1890 91	2,456.764	2,265,338	123 243	2,388,581	299,215	231,032
1891-92	2,545,612	2,507,012	124,883	2,635.895	298,883	389,166
1892-93	2,528.312	2,567,019	125,975	2,692,994	298,888	465,570
1893-94	2,579,206	2,641,020	116,625	2,757.645	298,888	477,327
1894 95	2,646,414	2,675.339	124,990	2,800,329	298,888	452,803

THE ENGINEERING INDEX—1895.

Current Leading Articles on Electricity in the American, English and British Colonial Technical Journals—See Introductory.

Lighting.

*1978. Tests of Incandescent Lamps (A singularly valuable paper, almost wholly statistical. Gives results, in tabulated form, after burning 350 hours, and after 600 hours,—amperes, candle-power, and watts per candle-power,—of six tests of lamps of thirty-four different European manufacturers). Ind & Ir-Oct. 4. 1000 w.

*2041. The Question of Raising the Voltage of Low-Pressure Electric Supplies (Difficulties that must be met. The change will therefore come about slowly if it comes at all. An altogether new make of lamp will be needed). Jour Gas Lgt-Oct. 8. 1000 w.

*2067. Stafford Electricity Works. Ill. (Historical and descriptive). Elec Eng, Lond-Oct. 11. 4800 w.

*2068. Electric Light and Power at Copenhagen Free Port (An object lesson in the practical application of electricity for all purposes in connection with dock work). Elec Rev, Lond-Oct. 11. 800 w.

*2177. Standardizing Incandescent Lamps. R. E. Richardson (An argument favoring uniformity in testing lamps and offering suggestions to this end). Elec Wld-Oct. 25. 2000 w.

*2207. The manufacture of the Incandescent Lamp in England. Ill. (The works of the Sunbeam Lamp Company, Limited, of Gateshead, described). Elec Eng, Lond-Oct. 18. 1100 w.

*2354. An Important Development in Arc Lighting (Description of a new lamp with a double globe so constructed as to exclude air containing oxygen from the carbons, surrounding them instead with carbon-monoxide; carbons are said to last 200 continuous hours without trimming.) Ind & Ir-Oct. 25. 1100 w.

*2355. The Electric Lighting of Edinburgh. Henry R. J. Burstall (Paper read before the Inst. of Mech. Eng. Description in full of all departments of works, etc). Ind & Ir-Oct. 25. 9000 w.

2389. Storage Batteries in Office Buildings. Charles Blizard (The use of these batteries as auxiliaries to the dynamos in buildings operating electric lighting plants. Advantages to be derived emphasized by data). Elec Eng-Nov. 6. 1400 w.

2421.—$1. Notes on the Reconstruction of a Small Central Station Plant. Franklin L. Pope (Consolidation of three different plants, and change from steam to water power. Paper read at Niagara Falls, June, 1895). Trans Am Inst of Elec Eng-Aug. & Sept. 6500 w.

2446. Studies of the Alternate Arc. Ill. (A review of a communication by H. Georges to the Electrotechnic Society of Berlin describing the experiments made in the last few years in the works of Siemens & Halske and Messrs. Oelschlager, Michalke & Queiss). W Elec-Nov. 9. 1500 w.

We supply copies of these articles. See introductory.

Power.

*1888. The Distribution of Electric Power at Niagara Franklin Leonard Pope and Ralph Wainwright Pope (A comparison of the differing views upon the possibilities of long-distance power transmission). Eng Mag-Dec. 6200 w.

†1903. Power Stations—The Latest Practice. Ill. (The advance made in electric power stations during the last five years reviewed. Some of the leading types in use at present examined and illustrated). St Ry Jour-Oct. 1800 w.

†1906. Long Distance Power Transmission for Electric Railways in Portland, Ore. Ill. (Power from waterfalls over long distance; three-phase transmission. Descriptive). St Ry Jour-Oct. 2700 w.

1936. Arnold's Power Station System at Fort Dodge, Iowa. Ill. (A commercial plant in operation, employing this system, installed under the direction of Mr. B. J. Arnold, described in detail). W Elec-Oct. 12. 1600 w.

1937. Electric Plow in Germany. Ill. (From report of Otto Doederlein, United States Consul at Leipsic. Describing its use in small husbandry, as well as husbandry on a large scale). W Elec-Oct. 12. 2800 w.

1962. The Two-Phase Alternating Current Power Distribution System at the Milwaukee Harvester Works. Ill. (Plant described and special features mentioned). Elec Ind-Oct. 1000 w.

1964. An Important Electric Railway Power Station. Ill. H. C. Reagan, Jr. (Description of the power house of the Hestonville, Mantua & Fairmont Passenger Railway of Philadelphia). Elec Ind-Oct. 1600 w.

1965. The Electric Rheostat and its Construction. Ill. E. D (The necessity and office of the rheostat explained). Elec Ind-Oct. 900 w.

*1986. The Benefits of Electric Traction (Having in previous articles discussed the superior merits of cable traction in many locations and under special conditions, this article has been prepared with the purpose of indicating the conditions under which electric haulage is legitimate, and even preferable to cable haulage). Ry Wld-Oct. 2200 w.

1987. Electric Railways and the Electric Launch Season of 1895. Ill. (Descriptive principally of the launches in use on the lakes at various resorts and parks. 1896 gives promise of being the best year that electrical navigation has seen in America). Elec Eng-Oct. 16. 2000 w.

1990. How to Throw on a Railway Generator. Ill. (The three usual methods of throwing a railway generator on and off the line explained for the benefit of subordinates in power stations). Elec Ry Gaz-Oct. 12. 600 w.

1994. Portable Electric Propeller for Boats. Ill. (An electric propeller, weighing but thirty-five pounds, that can be used on any row boat up to eighteen feet long. The rate of speed claimed is from three to five miles an hour). Inv Age-Oct. 150 w.

*2019. The Development of the Electrical Locomotive. Ill. John McGhee (An account of the development from the early attempts of our inventors to the realization). Elec Pow-Nov. 2600 w.

*2021. Principles of Dynamos. Ill. W. H. Freedman (Lecture delivered before the Henry Electrical Club. The rapid development of the dynamo electric machine. Not one of its principles known 100 yrs. ago). Elec Pow-Nov. 1800 w.

2036. Electricity in Railroad Work (Electric propulsion for railways considered in popular style and in nearly all of its aspects, commercial as well as constructive). Tradesman-Oct. 15. 1800 w.

2039. Long-Distance Transmission of Electricity for a Street Railway. Ill. (Plant located at Portland, Ore. Rotary converters in substations transform the three-phase current to direct current for the street railway lines. An interesting plant). Eng News-Oct. 17. 600 w.

*2064. Electricity Supply Meters. Ill. J. Warren (The writer will endeavor to give an idea of the principle underlying some of the most well-known forms of meter for registering the amount of electrical energy consumed in any circuit). Elec, Lond-Oct. 11. Serial. 1st part. 1000 w.

*2069. Distribution of Power in Collieries. Llewelyn B. Atkinson (Read before the South Wales Inst. of Eng., 1895. Pointing out how some of the difficulties under which this industry at present labors may possibly be met). Elec Rev, Lond-Oct. 11. 3500 w.

*2071. Generation and Distribution of Electric Power for Manufacturing Purposes. C. A. Stone and E. S. Webster (Abstract of a paper read before the New England Cotton Mfrs. Asso. Discusses the conditions under which it will be possible for mills and factories to effect a saving by the use of electricity). Elec Rev, Lond-Oct 11. 2000 w.

2115 Opening of the Carborundum Works at Niagara Falls. Ill. (Statement of events that led to the creation of the new works, with description of the plant). Elec Eng-Oct. 23. 1800 w.

*2163. The Electricity Works of the Great Northern Railway Company, Holloway, N. Ill. (Detailed description of an important and extensive power plant). Eng, Lond-Oct. 18. 3800 w.

*2201. Electric Travelling Cranes in Shipbuilding. Ill. (The operations of building are carried on beneath a structure 500 ft. long, 68 ft. wide and 80 ft. high, provided with travelling cranes so arranged that material may be transported from end to end, overhead, and therefore in no way interfering with the movements of the workmen). Elect'n-Oct. 18. 1200 w.

2253. Electricity on the Erie Canal. Ill. (Historical account of tests made, especially descriptive of the system of Richard Lamb). Elec Eng-Oct. 30. 3300 w.

2300. The Fair Haven and Westville Railroad Plant. Ill. (A very thorough explanation of the electric wiring of a trolley car, with many cuts from which a good idea of the complex

system may be obtained). Sci Am-Nov. 2. 1000 w.

2340. Electricity versus the Canal Mule (Showing, as the result of actual test, that horse and mule boatmen will save 82% of the present rate of tonnage, and steam canal boatmen will save 55%, on the present cost, if electrical power displaces horse, mule and steam). Ry Age-Nov. 1. 350 w.

2381. Electric Propulsion of Canal Boats. Ill (An account of the official test made at Tonawanda, N. Y., on Oct. 26). W Elec-Nov. 2. 3700 w.

*2386. An Experiment in Water-Wheel Governing. Ill. William W. Handy (A description of a simple electric governor by means of which very good regulation was obtained. An experiment carried out by the author on a turbine plant supplying current for incandescent lighting). Elec Eng, Lond-Oct. 25. 800 w.

2419.—$1. Long Distance Transmission at 10,000Volts. George Herbert Winslow (A careful illustrated description of the entire installation of the Pomona Plant with personal observations on its construction and operation by the writer, who installed the electric plant). Trans of the Am Inst of Elec Eng-Aug & Sept. 9000 w.

2422.—$1. Existing Commercial Applications of Electrical Power from Niaraga Falls. W. L. R. Emmet (Illustrated description of arrangements for supplying power, and apparatus used, with discussion). Trans Am Inst of Elec Eng-Aug & Sept. 6500 w.

2441. Calculations of the Weight of Accumulators Required for a Tramway. G. Chenet and H. Boy de la Tour (From *L'Industrie Electrique*. Mathematical formulæ enabling one to calculate rapidly the weight of accumulators required to draw a load, a, with a speed, v, along any track whatever). Elec Age-Nov. 9. 800 w.

2443. Electrical Equipment of Public Docks. Ill. (Description of the electric installation of the Public Docks & Lock Company of Copenhagen, designed to supply light and power for the loading and unloading of vessels, etc. The docks have been open since Nov. 1894). Elec Wld-Nov. 9. 2500 w.

2459. The Marvin Electric Rock-Drill. Ill. (Descriptive of the drill and the improvements made since the original machine was put on the market four years ago). Eng News-Nov. 7. 1800 w.

Telephony and Telegraphy.

*1953. The Field Telegraph in the Chitral Campaign. Ill. P. B. Luke (Paper read before Sec. G of the Brit. Asso. by the Deputy Director of Telegraphs in India. Brief description of the system upon which the military telegraph in India is worked, and its operations) Elec Rev Lond-Oct. 4. 4000 w.

*1955. Historical Outline of the Telegraph Service since 1870 (From the Postmaster General's Annual Report, with editorial. The report deals principally with the traffic returns and the engineering department). Elect'n-Oct. 4. 5200 w.

1966. The Telegraph in Canada. Charles P. Dwight (An account of the more important telegraph associations in Canada which have existed from the start). Can Eng-Oct. 3000 w.

1988. American and English Telegraphic Falling Off (Editorial comments on the recently published figures of the Western Union Telegraph Co. and the English Postal Telegraphs). Elec Eng-Oct. 16. 500 w.

2244. The Construction of Telegraph Lines (Giving details of construction in an interesting and condensed style, including methods and precautions in wiring and insulation). Eng News-Oct. 24. 1200 w.

Miscellany.

1912. Electricity in the Italian Navy. Ill. Guilio Martinez (Written with the authorization of the Italian Naval Department. Descriptive). Elec Wld-Oct. 12. Serial. 1st part. 2300 w.

1913. Electricity in Plant Growth and Light in Chemical Decomposition. W. Stuart-Smith (The object of this paper is to give a probable reason for the great variation in plant growth from year to year when there is but little apparent difference in the climatic conditions, and also to offer a possible explanation of the action of light in producing chemical decomposition). Jour of Elec-Sept. 2500 w.

1941. Reverbatory Electric Furnaces. H. Moisson (An account of what has been accomplished through the use of this improved furnace. The author feels convinced that the working of metals by means of the heat of the electric arc will be developed to a very high degree). Min & Sci Pr-Oct. 5. 1000 w.

1942. Earth Currents and the Earth Dynamo. James S. Lang (A theory of their cause). Min & Sci Pr-Oct. 5. 1000 w.

*1954. A New Battery Element. M. Morisot (Composition of element, with experiments under stated conditions). Elec Rev, Lond-Oct. 4. 900 w.

1959. Lightning and Lightning Protection. Leland L. Summers (Experiments and opinions of Dr. Oliver Lodge discussed and objections to his ideas noted. Other writers of prominence quoted. The most effective measures for protecting electrical consumers of energy are inadequate. Rules for erection of rods). Elec Engng-Oct. 3500 w.

*1976. Recent Improvements in Galvanizing (Difficulties hitherto experienced in depositing iron on zinc by electric current, claimed to have been overcome by the Cowper-Coles process. Described and illustrated with explanation of its rationale). Eng, Lond-Oct. 4. 700 w.

1989. Electrolysis of Pipes. Ill. (Suggestions for preventing the electrolysis of buried pipes. Advising that the copper returns be led back to the station by the shortest possible route). Elec Ry Gaz-Oct. 12. 1200 w.

1991. A Successful and Simple Method for Preventing Electrolytic Decomposition by Railway Circuits. Force Bain (A plan for reinforcing the return circuit is suggested, and asserted by the author to be an efficacious remedy for the trouble). Elec Ry Gaz-Oct. 12. 1000 w.

2003. The Best Way to Begin. T. Keppele

Hall (Advice to young men desiring to fit themselves for electrical engineers. What can be attained through practical training only—and the advantages of theoretical training). Elec Wld-Oct. 19. 2000 w.

2011. Time and Electricity (A brief account of a plan being agitated in Glasgow and London for establishing electric clocks in various places, whose time will be in electrical connection with the Observatory clock). Plumb & Dec-Oct. 1. 900 w.

*2017. Electrical Equipment of Modern Office Buildings. Ill. Joseph Sachs (Description of some of the electrical appliances in use in these buildings; especially for lighting and elevator power). Elec Pow-Nov. 4200 w.

*2051. The Late Sigmund Schuckert (Death and life record of this very distinguished German electric engineer). Engng-Oct. 4. 1000 w.

2091. A Submerged Electric Subway. Ill. (Detailed description of the conduit crossing of the Harlem River Ship Canal, New York city). Eng Rec-Oct. 19. 1700 w.

2114. The Woolf Electric Disinfecting Plant in Philadelphia. Ill. (The inauguration of the plant. Descriptive). Elec Eng-Oct. 23. 400 w.

2119. How Franklin L. Pope Lost His Life. Ills. (Details of the accident). Elec Rev-Oct. 23. 1000 w.

2133. The Thomson-Houston Regulator Patent (A statement of the case). Elec-Oct 23. 700 w.

*2178. The Hookham Electricity Meters (Descriptive of a meter possessing features of peculiar interest. Its advantages, etc.) Elec Rev, Lond-Oct. 18. Serial. 1st part. 2300 w.

†2194. Dynamo Design. E. B. Merrill (Paper intended as a help to engineering students, who, for the first time, propose to consider the subject of designing a generator or motor for a specific purpose). Eng Soc of School of Prac Sci-No. 8. 6500 w.

*2202. The Influence of the Shape of the E. M. F. Curve, upon the Iron Losses of Alternating Current Transformers. Clarence P. Feldmann (A contribution to the controversial literature of the "true sine curve." The author adds one more to the large number of facts which tell in favor of the flatter type of curve of electromotive force. Illustrated by diagrams). Elect'n-Oct. 18. 800 w.

*2203. An Apparatus for the Demonstration of the Development of Heat in Wires by Electric Oscillations. Ignaz Klemencic in *Wied. Ann* (Descriptive of an apparatus which will show the ratio of the heat developed by a steady current and by electric oscillations and be suitable for lecture experiments). Elect'n-Oct. 18. 1200 w.

2260. The Rating and Behavior of Fuse Wires. W. M. Stine, H. E. Gaytes and C. E. Freeman (Read before Amer. Inst. of Elec. Eng. Oct. 23. Investigations of fuse wires). Elec Rev-Oct. 30. Serial. 1st part. 2000 w.

2261. The Crandall Electric Signal. Ill. (A promising invention for use on sea or land). Elec Rev-Oct. 30. 600 w.

2375.—75 cts. The Thermophone, a New Instrument for Determining Temperatures. Ill. Henry E. Warren and George C. Whipple (Results of studies and experiments with the instrument with a view to adapting it to various scientific and commercial uses). Tech Quar-July. 9500 w.

2376.—75 cts. Experiments on the Relation of Hysteresis to Temperature. Ill. Frank A. Laws and Henry E. Warren (This paper gives an account of some experiments to determine the effect of temperatures much above the normal on the dissipation of energy by hysteresis in a specimen of steel). Tech Quar-July. 3300 w.

2385. Electrical Installation. William Brophy (A description of the appliances for the generation and distribution of electric energy for lighting, heating and power purposes). Arch & Build-Nov. 2. Serial. 1st part. 2000 w.

*2377. The Charging of a Condenser. Alfred Hay (The experiments described are intended as a contribution toward the mass of experimental evidence as to the existence of the oscillations which take place in the charge or discharge of a condenser when certain conditions as to capacity, resistance and inductance are fulfilled). Elect'n-Oct. 25. 1200 w.

*2378. Some Points Connected with the Preparation of Pure Iron by Electrolysis. W. M. Hicks and L. T. O'Shea (Paper read before the British Asso. at Ipswich. Details to be attended to to insure success by this method). Elect'n-Oct. 25. 1800 w.

*2379. The Control of Transformer Losses on Converting Systems of Electrical Supply. James Whitcher (Explanation of the writer's system, setting forth the salient points clearly). Elec Rev, Lond-Oct. 25. Serial. 1st part. 2200 w.

2382. Electricity in Japan. William E. Curtis (Its growing use in that country, with facts used to illustrate the broad scheme of industrial development occupying the minds of officials of Japan). W Elec-Nov. 2. 1700 w.

2390. The Opportunities for Electricity in China and Japan. William E. Curtiss, in the *Chicago Record* (The policy of Japan is opposed to granting any form of transportation or communication to foreigners. They may invest capital and find a market for material). Elec Eng-Nov. 6. 1600 w.

2418.—$1. The Cause of Death in Electric Shock. A. M. Bleile (The work here given was undertaken with a view to elucidating the effects of larger quantities of electricity on the organism. The value of artificial respiration after death by electricity was also tested. Experiments described. Discussion). Trans. of Am. Inst of Elec Eng-Aug. & Sept. 7000 w.

2420.—$1. Alternating Current Curves. Charles E. Emery (The subject carefully considered and mathematical formulæ used to represent curves. Discussed by M. I. Pupin and Mr. Steinmetz). Trans Am Inst of Elec Eng-Aug. & Sept. 9800 w.

2445. Water Rheostats. Ill. George T. Hanchett (A few practical suggestions concerning the use of water resistances). Elec Wld-Nov. 9. 800 w.

INDUSTRIAL SOCIOLOGY

British Commercial Supremacy Endangered.

NOT long ago we heard that British orders for architectural iron work were going over to Germany and Belgium, and that in some classes of iron construction English manufacturers could no longer compete successfully with makers in those countries. *The Engineer* (Oct. 18) seems struck with surprise and fear at the turn commercial affairs are now taking in the United States. In a leading editorial we find the following, apparently inspired by a recent able review of the commercial and financial situation published in the *New York Herald*.

"All our readers are aware that trade has been extremely active in the United States for some months. The mercantile position of that country presents, however, certain startling anomalies, which are enough to make the most earnest-minded political economist doubt the soundness of his science. Thus, for example, the country has been perplexed by two contending factions, one crying aloud for free silver money, and the other denouncing free silver money as a delusion and a snare. Furthermore, gold has been leaving the country at a rate which has created, if not panic, serious apprehension, and very remarkable expedients have been adopted by the American government to keep gold in the country. Such currency conditions are most unfavorable, it may be assumed, to the development of industries or the progress of trade. Furthermore, corn has fallen in value, and extraordinarily gloomy reports of the western farmer reach the coast,—where, however, they excite little interest, —and thence travel across the Atlantic to this country, where they are received with grim satisfaction by the English farmer whom the prairie settler has done so much to ruin. Yet, in spite of all this, we hear that the statistics of American trade for the past 8 months have taken every one by surprise; and no wonder! The highest value of United States exports heretofore reached in 1 year has been about $184,000,000. Apparently these figures refer to manufactured goods only, and not to corn. Should trade continue to flourish as it has done for the last months, then the year's exports will represent $228,600,000. The most remarkable gains are those made by woolen manufactures, chemicals, machinery, and refined mineral oils. For the 8 months of this year the gain in exported agricultural implements was over $500,000; in chemicals, over $680,000; in machinery, over $1,100,000; and in refined oils, nearly $8,000,000. But perhaps the most remarkable fact of all is that, according to the *New York Herald*, the value of the exports will have exceeded that of the imports to the extent of $17,000,000 by the end of the year. On many occasions discussions have taken place in our correspondence columns on the fact—if it be a fact—that all civilized countries, with a most insignificant exception, import commodities of all kinds to a value about twice that of their exports. No quite satisfactory explanation of this has ever been given, and it is worth while to state the nature of the problem. Four principal nations—say England, France, Germany, and Belgium —trade with each other. Let us call them A, B, C, and D. For the sake of simplifying matters, we shall assume that their transactions are equal, and we shall further take imaginary sums. A imports goods to the value of £200,000,000 from B, C, and D, and exports goods to the value of £100,000,000. The same statement holds good of all four. Thus, then, the import trade of the four represents a value of £800,000,000, and the export trade £400,000,000. How is the balance struck at the end of the year? Our readers must not buoy themselves up with the hope that we are going to give them the answer to this question. The exception to the rule

has, however, come at last, and the United States are exporting faster than they are importing. Now, if a country can get on and thrive while it is buying each year twice as much as its exports can pay for, it seems to be clear that a country exporting to a value much greater than that of its purchases must be amazingly prosperous. We shall not stop to ask how the United States exports are being paid for; apparently not with commodities, apparently not with gold. That point also must be left for political economists to wrangle about. The position in the United States presents us with a practical question of much more interest and importance. Has the long threatened day at last arrived? Are the United States about to become serious competitors of Great Britain in foreign markets?"

The Engineer then quotes the *New York Herald* as asserting that a new era is dawning upon American commerce, and as urging American manufacturers to make every effort to extend their foreign trade. The trepidation into which this throws our contemporary is somewhat amusing. It asserts that protection enables the American manufacturer to sell products abroad at lower prices than he gets at home, which is true,—at least of some products,—and adds that the standard of commercial morality with American manufacturers and salesmen is not up to the British standard, which is not true,—at least of many American manufacturers and salesmen. It urges English traders not to abate one jot of their honesty; as though the "weighting" of cotton goods and other similar fraudulent practices were things unknown in England, and the dealings of its trading classes in foreign and colonial markets had been always above reproach. But it betrays a curious moral squint when it says the "Yankee is clever and sharp," and that the proverb, "honesty is the best policy," is "far too crude to apply to such a case" as the one under consideration. It further says:

"We shall not say that in the long run honesty will win. If it does not win at once, it will not win at all. The theory is that, if an American sells rubbish and undersells the Englishman, after a while the purchaser will find out the difference and will buy the good article. Nothing of the kind happens. The purchaser does not in many cases know that what he has bought is rubbish. In others, rubbish answers the purpose perfectly. Then the standard of rubbish varies; and, having said this, we come to the point on which, of all others, we wish to insist, and up to which we have endeavored to lead our readers. It is that the cardinal weakness of the English manufacturer is that he will not sell what other people want to buy."

Finally, it asserts the belief that danger to British commercial supremacy is in sight, and it is altogether unhappy at the prospect. "A careful consideration of our own trade, past and present, is not comforting. It is better than it has been, but there was unlimited room for improvement. Our great shipping industries, for example, have been in a most unsatisfactory condition. Every week we publish long lists of ships launched; but what is the profit to the builders? What have been the dividends of the great building companies on the Tyne or the Wear, other than the Elswick firm? What have been the declared dividends on the Clyde? Shipbuilding has almost left the Mersey. And now we have a big strike on. The United States threaten to build ships for the whole world—and not ships only, but locomotives as well, and to roll rails for humanity in general. The potentialities of the country are enormous."

While the same is claimed for the commercial potentialities of Great Britain, its commercial methods are criticised, and it is more than hinted, in spite of the admonition not to abate honesty, that it is best to be just honest enough—not too honest.

Government Appropriations for the Maintenance of Commerce.

ANENT the proceedings of the deep waterways convention recently held at Cleveland, Ohio, *The Railroad Review* (Oct. 12) makes some editorial remarks which are directed against the general sense

of that convention that the United States government should make most liberal appropriations for the establishment and maintenance of deep waterways to the seaboard in connection with the great lakes. The right and power of the government to do this are not questioned; neither is the importance of a deep-water communication between the Atlantic and the lakes disputed. The policy of such paternalistic action is, however, viewed unfavorably.

The government has already expended vast sums for improvement of waterways, much of which has been wasted so far as the specified purposes of these appropriations are concerned; and, in many cases, the so-called improvements were unwisely projected. The relation of the railroads to commerce is stated as follows:

"Of late years, however, a new element has been introduced into this subject of commercial movement, which, although involving a somewhat different method of application, is nevertheless based upon the same principles as those previously controlling. Government found the waterways ready to hand and simply assumed control. Ordinary railroads, although constructed by government, were equally open and free to all who chose to traverse them, but the new element of railroads introduced a different method. While requiring government sanction and subject to government supervision, the element of private ownership was present in larger proportions than had previously been employed. The character of the service required that public vehicles should be excluded therefrom, and altogether the proprietary interest was so manifest that it has come to be accepted that, while railways in common with all other recognized channels of commerce are subject to the regulation of government, they of all such channels are not entitled to the support of government in the way of either maintenance or betterment.

"It is just possible that such a conclusion is erroneous. There are many things in common between the railroad and other channels of commerce. In order that commerce may be promoted, government exercises its rights of eminent domain in the appropriation of landed property for the purpose of constructing roads, enlarging rivers, building canals, etc., and, because of the same commercial necessity, this right of eminent domain is granted to railroads. Government also assumes to regulate the use of commercial channels, the railroads as well as the waterways and roads. It prescribes that certain conditions shall be maintained in order that the safety of passengers and property in transit may be assured, and that no interruption of, or discrimination in, the service shall be permitted, so that in many ways—in fact, all ways except that of ownership—the conditions attaching to these three channels of communication are practically analogous.

"The same is true of the uses to which these means of transport are put. Each channel is free to all who may seek to use it. A railroad is not obliged to admit to its tracks the vehicles of the public, but it cannot refuse to transport persons and property when tendered under proper conditions. Whatever may be the facts as to the conveyance itself, the service is a public one and must be open to all alike. Should this service be interrupted by force, it is now admitted that in all cases government has the right to step in and do whatever is necessary to keep the channels of commerce open. In short, the supervision, regulation, and, if necessary, the control of transportation is a government function that cannot be abrogated if the purposes for which it is established are to be maintained,—to wit, equal and exact facilities for all."

The government has, moreover, assumed "a larger supervision of railroads than of any other means of communication." It even "claims the right to control the compensation charged for service, and to direct the way in which accounts shall be kept." In view of these extremely close relations existing between the government and the railroads, our contemporary sees no grounds upon which an appropriation for the improvement of a waterway can be asked for that would not apply with equal force to a railway, and with this view we are compelled to agree. Yet, were it now proposed that such government aid should be

extended to railway improvement, a wave of protest would sweep from the Pacific to the Atlantic coast.

How congress will act upon the resolutions adopted by the convention remains to be seen; but there appears no reason why they should be favorably regarded. We believe that such a waterway, if ever constructed, should be constructed by private enterprise, unaided by government.

How Work People are Housed in Berlin.

THE United States Consul in Berlin, in one of his reports, gives some interesting details of the miserable housing of the working classes in that city. The abstract of this report given herein shows their state to be pitiable. In 1890 the population of Berlin was 1,436,233. Of this number 318,753 heads of families paid income tax under the 900-mark limit (the value of a mark is between 24 and 25 cents), while an average laborer, with wife and child, should have from 1575 to 1750 marks' annual income to occupy the smallest quarters, reckoning rent at one-fifth his income.

Capital has been embarked in the building of new quarters of the city, and tenement buildings have been neglected. As a consequence there has been a failure to provide small buildings, apartments, and small suites of rooms, and, in many cases, the poor have been driver still closer together in such buildings as previously existed. The moving of factories employing many hands towards suburbs not inhabited by the rich, and the rise in the rents in the city proper, have forced the poorer classes towards the outskirts. Efforts have been made to provide laborers with small, separate houses still further out, but this is not practicable on any large scale for the really poor. They must live near their work and near the centers. It is recognized that laborers must live near together, in order to live on their present wages.

The average daily wages of an adult male is only 2.40 marks, which, at 300 working days, gives but 720 marks annually. The rent of one room and kitchen in the back part of the house, where air is poor and often foul, is reckoned, at an average, from 250 to 270 marks; rent of a room with two windows, or one-windowed room and kitchen, 315 to 350 marks; the rent of an apartment with a two-windowed front room, one-windowed back room, corridor, and kitchen, averages 450 marks. A workman, with wife and child, must, therefore, spend about 315 to 350 marks annually on his rent alone, or nearly one-half of what he makes as an average wage earner. Hence it is necessary that wife and children must work to help pay the family way, and any small floor, bed, or sofa space that can be squeezed out is let to more or less permanent tenants for the night. These sub-lodgers are called *Schlafburschen*. They are of both sexes and all ages, and comprise the hard-working, sober young laborers, steady girls, widows, and widowers, as well as the floating population, which deals in and distributes vice, infectious diseases, and punishable crimes. Efforts have been made to stop this sub-letting, and the Berlin police are active in their endeavors to regulate and check such abuses. One evil result of such herding together of the sexes is the number of illegitimate children born to very young girls. The tenement house in Berlin is not so easily recognized as in some other cities, owing to the admirable cleansing and police system and the appearance of the houses, which is often imposing; but the houses themselves cover much misery. A common thing is a broad, high, massive front, broken by an arched passage, which leads to one, two, or three courts. The back courts are often ill-kept, narrow; and foul, violating the rules which prescribe so many cubic feet of air to the human body. They are often old buildings, by no means calculated for the human strain to which they are subjected, and lack conveniences, especially water-closets. In these houses the worst mortality occurs in garrets, the cellars ranking next. Garrets are more fatal, perhaps, because of the greater cold, or the strain on the old and sickly from having to ascend and descend stairs; or it may be that garrets are slightly cheaper than cellars, the latter being largely rented by dealers in old rags,

iron, etc., so that the poorest of the poor people, weakened by disease and hunger, and predisposed to greater mortality, take to the garrets. Cellars are also occupied by men and women who take charge of the cleaning of the houses. Even in the best houses the gatekeepers or *portiers* live in very badly-lighted, badly-warmed, and ill-ventilated rooms, considerably below the level of the street. In the back parts of tenement houses these evils are much worse. In 1880 as many as one hundred thousand people lived in cellars. In that year attention was drawn to the excessive crowding of the floating population in large single rooms, locally called *Pennen*, which were really breeding grounds for epidemics. The worst of these were done away with then, but there is a constant tendency to their revival, in defiance of the police. Cellar dwellers suffer from eye disease and rheumatism, owing to the lack of light and the dampness of the walls. As lately as 1893 the number of cellar dwellers was reckoned at one hundred thousand, and there is no reason to estimate them at a lower figure now.

Is it not possible for architectural skill and inventive talent to devise for people of small means better city habitations than the world has yet seen? This herding together of working people is not peculiar to Berlin; though it exists there in an aggravated form, it is found in nearly all European cities, and is an increasing evil in American cities. No problem in architecture is of more immediate and pressing importance than this.

Reconstruction of Old Cities.

A PROPOSITION which comprises a scheme for the reconstruction of old cities has been made by a London clergyman. *The Architect and Contract Reporter* (Sept. 27) apparently does not think this scheme too absurd for notice, as it reprints it. The author professes to outline a method whereby "the question of the unemployed" can be treated, and this or some similar scheme will, in his opinion, force itself upon public attention as soon as the unemployed become sufficiently numerous, and the question of providing for them becomes sufficiently urgent. This contingency, he declares, is near at hand, and the reconstruction of cities—notably London—is proposed as a solution of the question. That anything will need to be done for the unemployed after the cities are reconstructed does not seem to have occurred to Rev. Dr. Parker, who has the honor of making the proposal; or, if it has, he probably contemplates an extension of the scheme to the continuous reconstruction of cities. Tearing down cities and building them up again would continuously supply much work; that for many cities it would be superfluous work, entailing much greater expense than the wages that would be paid for it, and that, while in progress, it would more or less unfit the cities for the purposes of cities as centers of business and homes for citizens, are considerations that do not seem to have been heeded. It would cost far less to pay the (estimated) amount of wages that could be thus earned directly to the unemployed, and let them remain idle, than to carry out the scheme.

There is, however, little doubt that many old cities might be reconstructed, with benefit to all who would subsequently inhabit them; and this consideration may possibly justify Dr. Parker's scheme for the reconstruction of London.

First, a thorough and scientific system of drainage would have to be considered and supplied. "The drainage of London," says Dr. Parker, "is unquestionably bad. It is in this direction that infinite mischief has been done by malicious or careless workmen. To my personal knowledge the drains of one of the finest buildings in suburban London have never been connected with the main sewer. What has hitherto been done in piecemeal in the way of good drainage must be done according to the scale of the whole area."

The idea of local centers is regarded as the basis of any "adequate, workable scheme of reconstruction." Accordingly reconstructed London "should be laid out in main centers, such as the railway center, the market center, the shipping center, the educational center, the hospital center, and the like.

"There should also be an ample system of subways; a London out of sight. In connection with the subways should be all gas pipes, all electric wires, all telegraph apparatus, all water-mains, and all lamp-lighting machinery, the whole so distributed as to be accessible in every part without disturbing the streets or embarrassing the traffic, and so protected as to be safe from the severest frost. The last point is of supreme importance, as shown by the memorable frost of 1895. The proper construction of subways would overcome the nuisance and difficulty connected with the removal of household refuse.

It is further suggested that the Thames might be straightened, and wharves, warehouses, and offices built after the manner in which they have been built in Liverpool. The streets could then be laid out north and south from the river, with wide east and west intersections. A seaway between London and Brighton is also suggested. Quoting Brunel as saying that the lack of money is the only difficulty known to engineering, Dr. Parker says there would be no lack of money for rebuilding London. "Parliament knows how to deal with vested interests, and we are face to face with unemployed millions which would be instantly placed at the service of any legally-constituted court at a very moderate rate of interest."

In conclusion, it is urged that the question of plans (all historical buildings to be preserved) should be submitted to the Institute of Architects, the Society of Arts, and the Institute of Civil Engineers.

The Upward Movement of Silver.

THE rise in silver both in the London and American markets has excited surprise and comment, as something generally unexpected. Yet at the time the recent issue of United States gold bonds was pending one of the Rothschilds was quoted as expressing the belief that silver might possibly yet rise to a par with gold, and *Bradstreet's* (Oct. 12), commenting editorially upon this phase in the world's financial affairs, says it was foreshadowed by the recent speculative improvement in the silver-bearing obligations of the Indian government at London.

The rise was sudden and sharp. In the week ending Oct. 19 it rose to 31 3 16 d in London, and 69 cents in New York, whereas for many months the price of bars in New York has been about 67 cents per ounce.

Our contemporary also notes a significant indication; "both here and abroad there has been a sudden revival of what may be termed speculative attention to silver and its movements. This is shown by the fact that, after many months of inactivity, the silver bullion certificates, representing metal deposited with a safe deposit company in this city, have again been traded in on the New York stock exchange, which, owing to withdrawals, has shrunk to very limited proportions.

"The foundation of the movement, which may be regarded as another manifestation of the tendency of all commodities to advance, is found in increasing demands and limited supplies. The large smelting organizations in this country continue to turn out silver bars up to their full capacity, but, on the other hand, within the last few years, many low grade mines and reduction works operating upon that class of ores have been forced by the lower prices to either curtail or suspend their work. It is estimated, indeed, that the actual output has recently averaged about 160,000 ounces per month, and this amount is easily absorbed by the demand for use in the arts and the constant shipment to Europe. The demand, on the other hand, has been augmented, without doubt, by the financial conditions at the east, arising from the war between Japan and China, and the expansion in the trade of British India. It is, indeed, understood that the amount of silver arriving in New York has of late been greatly curtailed on account of heavy shipments from the smelters direct to San Francisco, the metal going thence to China. This, it has been found, is easier and less expensive than the custom which has obtained for some years of forwarding silver to New York and thence to London, where it is again shipped to the east,

There is, however, a belief in some well-informed quarters that both the Japanese and the Russo-French financiers who are aiding the Chinese government have been large purchasers of silver. Their operations in this respect have been conducted with great care and no small degree of secrecy. How large such accumulation may be, or what their probable amount is, cannot, of course, be even estimated, while there is also considerable doubt as to the basis for reports that certain large interests have accumulated silver with a speculative purpose in relation to the ultimate outcome of financial affairs in the two far-eastern empires."

It is also noted that "the expansion of trade throughout Great Britain's eastern dependency" is producing, and is likely to produce, an increased demand for silver in that quarter of the world. There are also indications, in the utterances of the London financial papers of recent date, of the possible coinage of a large amount of rupees. Another fact tending to advance the price of silver is its increasing use in the arts. "It is the opinion of the trade that the consumption of the metal in this form . . . . now constitutes a means by which a very considerable portion of the entire silver product of the United States" will be annually absorbed, and there is no prospect of its decrease.

"The effects of the movement, though it has barely started, upon silver mining industries and the general trade of our own western States is a matter calculated to attract general attention. It is the opinion of many authorities that a stable silver market, even a few cents higher than the recent level, would result in the re-opening of many mines and smelters which have been idle for a considerable period. The effects of this, not only upon general trade interests, but upon the railroads throughout large sections of the west, can be easily appreciated, when it is recalled that the disasters which overtook a number of prominent corporations of that kind during the last 3 years are directly attributable to the heavy and persistent decline of silver."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Industrial Sociology in the American, English and British Colonial Technical Journals—See Introductory.

*1898. The Financial Outlook in America. By a Banker (The gold exports of the United States, from Jan. 1, to middle of Sept. exceeded the gold imports by $27,702,000. An attempt is made to account for this drain of gold). Bank Mag, Lond-Oct. 1400 w.

*1899. The Coming Flood of Gold. W. R. Lawson (A review of the economic history of the gold movement. The danger now seems to be the over abundance of gold. The recent progress is nothing compared to what is predicted for the future. Not only new mines, but improved processes are contributing to the supply. The right of gold to be regarded as capital has never been conclusively established. Remedy suggested for the evil of excessive currency is restriction). Bank Mag Oct. 6400 w.

†1900. Co operation in Agriculture. Henry W. Wolff (The needs of agriculture in England, with remarks on remedies tried and suggestions offered. Agricultural co operative supply has been successfully practised in France, Germany, Austria, Italy, and Switzerland. Its advantages set forth). Contemporary Rev-Oct. 4800 w.

1944. Silver's Upward Movement (The foundation of the movement is found in increasing demands and limited supplies. India's influence: Increasing use of silver in the arts. Its effects). Bradstreet's-Oct. 12. 1000 w.

1982. Government Appropriations for the Maintenance of Commerce (An editorial argument against greater propriety of any government appropriations to improve waterways, than for the maintenance of railroads). Ry Rev-Oct. 12. 1500 w.

†1997. English Industry and Eastern Competition. R. S. Gundry (Tracing the industrial complications arising from the protection of gold, and favoring the restoration of silver to its full rights). Fortnightly Rev-Oct. 5000 w.

2053. A Study of the Growth of Cities. Elmer L. Corthell (Abstract. The writer expresses the belief that the growth of the six largest cities in the world will steadily continue, and thinks that in 1920 their population will be for London, 8,344,000; Chicago, 7,797,600; New York, 6,337,500; Paris, 3,808,580; Berlin, 3,442,221; Philadelphia, 1,838,760. He gives reasons for this belief and illustrates the growth of each city on a diagram). Eng Rec-Oct. 12. 1200 w.

†2056. The Maintenance of the Gold Reserve (This able editorial shows that the amount which has to be borrowed $70,000,000 in 18 months—indicates the amount that has been wasted in maintaining the gold reserve when there has been a surplus, and estimates the expense of maintaining specie payments in the United States at $46,000,000 annually). Rhodes' Jour of Bank-Oct. 700 w.

We supply copies of these articles. See introductory.

†2057. A Popular Loan (Editorial attempt to prove that a popular loan at this time on any terms the U. S. government is likely to offer is a chimera, and that anything less than a 4% bond in gold would not sell in any quantity in the open market). Rhodes' Jour of Bank–Oct. 800 w.

*2165. The Rivalry of the United States (Editorial discussing the fact that the United States will this year export more than its imports, and considering this as an indication that this country is about to become a powerful competitor with England in the markets of the world). Eng Lond–Oct. 18. 1800 w.

2220. Reaction in Prices During the Past Quarter (Besides reviewing the trend of prices for the past quarter, this article contains a full-page tabulated comparative statement of 109 staples for 1891–2–3–4 and 5, which is an exceedingly valuable table for reference). Bradstreet's–Oct. 26. 1000 w.

2222. Labor Contests Since 1881 (A review of the so-called militant side of labor organizations, down to June 30, 1894, based upon the tenth annual report of Hon. Carroll D. Wright of the U. S. department of labor). Bradstreet's –Oct. 26. 600 w.

*2250. Customs Tariff of the Bahamas (Table of duties and table of exemptions). Bd of Tr Jour–Oct. 1800 w.

*2251. Tariff Changes and Customs Regulations (Belgium, France, Spain, Italy, Austria, Roumania, Brazil, Chili, Uruguay, British India). Bd of Tr Jour–Oct. 6200 w.

†2270. Why Does the South Want Free Silver? John T. Morgan (The extreme position is taken in this article that the use of silver money will prevent inflations and depressions of values and prices, and that it furnishes labor with the only safe and convenient measure for the value of a day's work. The interest of the South in favor of free silver is ascribed to an alleged appreciation of these assumed facts. The usual stock arguments are employed in support of these propositions. It is further alleged that the silver dollar is the most useful money for the people, that it is not dangerous to anybody, and that it never did, and never will do harm, with much else in the same vein, which while alleged, is far from being ably sustained by the arguments put forth). Arena–Nov. 7000 w.

†2272. Jingoes and Silverites. Edward Atkinson (Facts tending to prove the erroneous views advanced by the so-called "jingoes" dangerous to the country, and showing the negligence of the mass of thinking men. Arguments all favor the gold standard). N Amer Rev–Nov. 3000 w.

†2273. Industrial Development of the South. W. C. Oates (A brief summary of what is going on in Alabama at present as a typical southern state). N Amer Rev–Nov. 3600 w.

†2275. True Source of American Wealth. Ben F. Clayton (The subject is not discussed from a scientific standpoint. The writer considers the natural product of the soil, aided by intelligent labor, to be the only source from which wealth may be obtained to meet all obligations). N Amer Rev–Nov. 2300 w.

2281. Protection Required for Both (Address by Col. A. L. Conger at 2d annual meeting of the Agricultural Implement Manufacturers at Chicago, Oct. 22, advocating the "Lubin System"). Sca–Oct. 31. 1400 w.

*2290. Plutocracy and Paternalism. Lester F. Ward (An attempt to make an unbiassed analysis of the meaning of these terms in their relation to the existing state of affairs in the country). Forum–Nov. 4500 w.

*2291. Coöperation Among Farmers. Edward F. Adams (Some of the fundamental difficulties in coöperation. A description of the movement to unite the orchardists of California in marketing their fruit). Forum–Nov. 5800 w.

†2292. Principles of Taxation, David A. Wells (A discussion of the principles of taxation from a broad basis, special consideration being given to the experience of the United States). Pop Sci M–Nov. 5000 w.

†2293. Recent Tendencies in the Education of Women. Mary Roberts Smith (A review of the past methods of education for women, and their results, and predicting that woman will soon be able to obtain as broad and as specialized a training as her needs shall require). Pop Sci M–Nov. 2600 w.

†2294. The Past and Future of Gold Charles S. Ashley (An article written to present the evidence that has led the writer to the conclusion that the demonetization of silver has caused an appreciable fall in the value of gold). Pop Sci M–Nov. 3800 w.

2305. Bank Clearings Heavily Increased (These statistics indicate a trade activity and an expansion of business larger than in any previous month since May, 1893. A marked tendency toward enlarged trade in the northwest and south is also apparent). Bradstreet's–Nov. 2. 600 w.

2306. Possibilities of Trade with the Baltic. L. O. G. Amundsen (A communication from the acting Danish consul at New York, giving facts relating to commerce and indicating possible extensions of trade between the United States and Denmark). Bradstreet's–Nov. 2. 1700 w.

*2417. Production of Gold and Silver (An endeavor to ascertain what the production of gold at the present time is, and what the prospects are of its progress. A table is given of the production of gold and silver in the world since the discovery of America; also a table of the approximate stocks of money per capita in the principal countries of the world including gold, silver and paper, arranged from the highest to the lowest). Banker's Mag–Nov. 3500 w.

*2424. Upon Sundry Labor Questions (The inevitable strikes that have followed the revival of trade and which it is assumed will follow such revivals as long as the present wage system remains unmodified, are made the text for an argument favoring profit sharing as the only remedy for strikes). Jour Gas Lgt–Oct. 29. 1800 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Water-tube Boilers for Marine Service.

THE application of water tube boilers to marine purposes meets with the opposition usually encountered by innovations affecting a wide field of commercial operations. Some recent mishaps and partial failures have been seized upon and made the most of by those whose interests are, or will be, adversely affected by the extended employment of water-tube boilers for ship propulsion. These reviews, being independent of any such interests, may, and ought to, present views on both sides. Favorable accounts of the operation and economy of water-tube boilers have been previously reviewed. Unfavorable opinion is represented in *Engineering* (Sept. 6) by a long communication written by James Howden of Glasgow, and by a correspondent who signs himself "Argus." The latter makes a criticism of water-tube boilers for marine propulsion, and of the Belleville boiler in particular, the performance of this boiler in the Wilson liner, Ohio (late Egyptian Monarch), supplying material for such a criticism. He says these "performances were expected to prove, beyond the shadow of a doubt, the superiority of such boilers as steam generators to those of the cylindrical type, and to justify the admiralty in adopting them." Yet these performances, it is claimed, were very unsatisfactory.

The Ohio is fitted with four Belleville boilers intended to develop 1500 h. p. with a working pressure of 200 lbs. per square inch. These boilers have 192 sq. ft. of grate, 6000 sq. ft. of heating surface, and can carry a 250 lbs.' pressure; so that the normal power of the ship is less than eight per square foot of grate, and she has 4 sq. ft. of heating surface per indicated horsepower,—conditions, both as regards engines and boilers, so favorable as to be out of comparison with those of any other regular Atlantic liner; and the "woeful mess" the ship "has made of it is just as far out of comparison with their performances. These boilers represent one-eleventh of the installation in the Terrible; so, for the latter's trial power of 25,000, the Ohio should show 2200; and, unless the latter can maintain 1800 continuously at sea, the Terrible cannot maintain 20,000, which is what she is built for."

Very severe criticisms by this correspondent are followed by the question: "We want to know why this British ship, a large and fine one for her speed, with extremely modern machinery and a lavish boiler installation, should make protracted voyages, and then anchor short of her home port in such deplorable condition that a tug had to be sent to convey her home?"

"Argus" says the Belleville boiler was adopted by the British admiralty under the representation that "there was nothing experimental about it, but the Ohio's experiences show that it is all experiment."

In his communicaton, Mr. Howden promises a future letter to prove from actual facts the inferiority of water-tube boilers for marine use. He asserts that they consume more coal per power unit than cylindrical boilers, and require a greater number of stokers for a given power. He declares that, when the debate on water-tube boilers in parliament last April was on, "the only case known . . . . in which water-tube boilers had been tested under equal conditions, at a fairly high power, against cylindrical boilers, was that of the Newhaven and Dieppe steamers Tamise and Seaford, the former having Belleville boilers and the latter cylindrical boilers"; and he adds: "In my letter to the *Times* of April 9 last on this subject, I gave particulars of the performance of these two steamers at equal power and speed. The respective consumptions of coal in the same period were 37 tons for the Tamise and 27 tons for the Seaford. This important difference at once establishes the fact that the coal necessary to propel a warship 1000

miles with Belleville boilers would propel the same warship at the same speed 1370 miles with cylindrical boilers of the same relative economy as those of the Tamise and Seaford. It likewise follows that, if in each case the stokers perform equal work per day, thirty-seven stokers will be required to produce the same power with the Belleville boilers that the cylindrical boilers will give with twenty-seven stokers.

"The experience derived from the working of these steamers regarding the comparative durability of their boilers is of the highest value. Though the passage each way is performed within 3½ hours, or less than 7 hours' working out of 24, the Belleville boilers of the Tamise have, since starting, required constant repairs, several being so extensive as to lay up the steamer for more than a week at a time. The cylindrical boilers of the Seaford, until her unfortunate loss, have required no repair, and the steamer has run since starting without a hitch.

"These vitally important facts, proved by a year's running of these two steamers, could in no way be met by the admiralty or by the supporters of the Belleville boiler, and consequently in the official defence they were not referred to."

These are samples of current adverse criticism on the subject of the adaptation of water-tube boilers for marine service. They do not prove the impossibility that this class of boilers may ultimately supplant the cylindrical type for ship propulsion. They do show, however, that we are not beyond the stage of uncertainty and experiment, and that very much yet remains to be done before the question of water-tube *vs.* cylindrical boilers can be defintely decided.

Oriental Engineering and Shipbuilding.

THE whirl of events seems to have reversed the saying, "westward the star of empire take its way," so far as it applies to the empire of the human mind, which controls the forces of nature and makes them obey human will. The far east, with its vast natural resources of mine, field, and forest, will probably be the scene of the next great chapter in human progress.

At a recent meeting of the Institution of Engineers and Shipbuilders, at Hong Kong, Mr. William C. Jack read a paper which *The Steamship* (Oct.) has reprinted, and in which the primary object of the institution is stated; this purpose is to expand the profession and encourage shipbuilding at Hong Kong, which is regarded as a very favorable location for the industry. Mr. Jack says: "We've got the tools, we've got the men," and in his paper he certainly makes a good showing of other advantages. Whether there are disadvantages that will offset the advantages, we are not able to decide. In the course of the paper some disadvantages are admitted,—for example, the time required at Hong Kong to get steel orders filled. Mr. Jack said:

"Hong Kong has long been famous for its splendid fleet of steam launches, for whose fine models the Chinese carpenters of to-day are indebted to our predecessors, the pioneers of modern shipbuilding in China. These models would do honor to the first yacht builders in the world; still, there will be many . . . . who can remember when the best of them were propelled by a single or double high-pressure engine, and no one can say, when they look at the beautiful compound surface-condensing and triple engines which propel our launches of the present day, that our engineers have been lagging in the march of improvement. A step from the teak wood launch to the steel or composite steamer of modern dimensions came next, and Hong Kong has supplied its neighbors, from Japan to Australia, from the Philippines to India, with specimens of the work that can be turned out here." Speaking from experience, the author alleges that the Hong Kong-built boats belonging to the firm with which he is connected defy comparison as far as hull, engines, and boilers are concerned,—that is to say, they are ahead of the home-built article in finish, workmanship, and durability. To-day Hong Kong is in a position to turn out and equip sea-going steamers in every way equal to the home article, and more in accordance with the requirements of the country and the eastern trade.

The question of price, which, from the

owner's point of view, is of controlling importance, is also treated from the standpoint of the author's personal experience in the shipbuilding and engineering establishment in Hong Kong, of which he is the manager. On this point he says: "We have been able to show, by supplying the government with a light draught gunboat, built in pieces, transported and erected on a river in the interior, that the work could be done more economically than it had been done in France, in the case of boats built for the same service, and this handicapped as we are in Tonkin with customs and other duties. The difference in cost when a boat can be launched and finished at the works may be imagined. It may be put forward that building costs more in France than in England, as it does; but the author may state that the type of boat of which the writer's firm makes a specialty—the stern-wheeler—can be put in the water and finished for less than the F. O. B. price of builders of the same type of steamer in England. Paradoxical as it may appear, it is the low rate of exchange that favors us, as will be seen by the following table of the comparative cost of a steamship of moderate dimensions.

	Cost at Home.	Cost in Hong Kong.
Iron shipbuilders' work	£5889 0 0	£5987 2 0
Carpenters' work	2000 0 0	1576 18 0
Riggers' and smiths' work.	573 0 0	551 0 0
Joiners' work	2582 0 0	2116 19 0
Painters' work	387 0 0	293 5 0
Sails, compasses, etc	1037 0 0	1173 16 0
Sundries	362 0 11	345 7 8
Management, etc	459 0 0	918 0 0
Donkey boiler and winch mountings	309 0 0	370 16 0
Engines and boilers	6346 11 9	6348 2 9
Interest on total, 5 per ct.	997 4 7	.....
Interest on total, 10 per ct.	.....	1968 0 7
Totals	£20,941 17 3	£21,648 7 0

"The home prices are taken from the most reliable sources and carefully verified; of course, they may rise or fall according to the demand, but may be taken as a fair average. The deductions or additions thereto are from the author's own experience, and will, he thinks, fairly represent the cost of the same steamship if built in Hong Kong. The wages rate allowed is much higher than actually paid here, but something must be allowed for the inefficiency of the native workmen, who in heavy work cannot be expected to compete, man for man, with their European brethren." In Mr. Jack's opinion the wages rate at Hong Kong would be less than one-third of shipyard wages in England; a considerable economy would also be realized on any materials which could be bought at silver value in the country,—woodwork, for example. Teak and many other kinds of splendid timber can be had at prices which cannot be touched in the home market. Steel, pig, bar-iron, and sundries would of course be augmented by the freight out.

Mr. Jack then proceeds to compute the difference in cost of building a steam-ship respectively in Hong Kong and in a British shipyard, and finds the difference to be 13s. 10d. per gross ton, which difference, he alleges, would be more than swallowed up by the voyage out, to say nothing of the fact that, on arrival, there are further expenses and delays in overhauling, paying off and sending home crews, and often for docking. Taking all the expenses into account, as stated by the author, the ship built at Hong Kong could be delivered to its owner in Chinese waters, with a fair profit to the builder at less cost than that of a similar ship built in England.

The Lake Ship-building Industry

THE ENGINEER (London, Oct. 12) makes this the subject of an editorial, in which it alleges that the completion and opening of the Canadian ship canal at Sault St. Marie will render the tonnage of the American lake marine obsolete, and predicts that the supply of vessels adapted to the new conditions will give business to the western shipyards for some time to come.

The argument is based upon the facts that the canal on the American side has hitherto afforded passage only for ships of from 14 to 15 ft. draught, while the new canal affords a draught of 20 ft., and that, as a consequence of the understanding between the governments of Canada and the United States whereby both canals may be used on the same terms by ships of both countries, there will be brought into existence a fleet of vessels which can use only the deeper waterway. The effec

of this upon ship-building and ship-owning interests on the lakes will, in the opinion of *The Engineer*, be most important and far-reaching.

The way in which the former draught limit has influenced the design and construction of ships on the lakes is thus explained. "With one dimension,—*viz.*, depth, a constant quantity,—it necessarily followed that all increase in the tonnages and carrying capacities of the lake steamers could only be effected by augmenting the other two dimensions of length and breadth. This has been carried out to such an extent that it is no uncommon thing to come across steamers having such abnormal proportions as twenty and twenty-one depths in length to main deck. This feature, combined with the enormously wide and numerous cargo hatchways in the steel topsides, necessarily tended to produce structural weakness, so that, in several cases wherein adequate compensation for excessive proportions and large openings in decks and sides had not been provided, signs of straining were evinced; and two such vessels were lost under grave suspicions of having broken in two. For many years, then, the cry has gone up, from Buffalo to Duluth, for a deeper channel way.

"But deficiency in depth of water has not been limited to the Sault Sainte Marie canal. The small Lake St. Clair and the river St. Clair, which joins it to Lake Huron—the whole forming, with the Detroit river, the junction between Lakes Huron and Erie—have also been hindrances to deep-water navigation. But, as the fall between the two lakes is only about 8 ft., and the channel admits of dredging, the conditions to be found at that part of the large fresh-water system are now at least as good as have been provided at the Sainte Marie river. It is in the river and harbors on the United States side of the lakes that the most serious hindrance to the further deepening of the draughts of lake vessels will be found. The rivers Chicago and Calumet at Chicago, the Cayuga river at Cleveland, and the creeks and channels at Buffalo, which in effect constitute the harbors at these important cities, have nowhere more than about 15 ft. of water. As all the wharves, storehouses, granaries, &c., for the loading and discharging of vessels are on these shallow streams, it is evident that they too must be dredged deeper, if they are to be of use for vessels drawing as much as 20 ft. But to dredge them deeper would be to weaken the foundation of the huge buildings on their banks, and bring them to the ground. Competition will, soon end their usefulness, for the deep-draught, large-carrying steamers will drive them out of the struggle, and the narrow, shallow, muddy, and malodorous rivers at Chicago will in the end be doubtless covered over and hidden as effectually as the Fleet and other tributaries to the Thames which once flowed openly through the city of London."

The effect upon hitherto unavailable and unprofitable sites for lake ports is open to conjecture, but our contemporary thinks that the fact that a firm in Detroit —a city more than 1000 miles inland—has already contracted to build three steam vessels for navigating Russian rivers, and that from this point ships may be sent through the canal and across the ocean to Europe, ought to set English shipbuilders to thinking. There have been other indications of commercial apprehension in the British press of late. One will be found in our department of "Industrial Sociology."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Technical Journals—See Introductory.

*1894. The Great Modern Transatlantic Steamships. Ill. Samuel Ward Stanton (Reviewing progress in construction of ocean steamers from 1881 to 1895). Eng Mag–Dec. 4500 w.

1915. The Launch of the Armored Cruiser Brooklyn Ill. (Brief description calling attention to new features). Sci Am–Oct. 12. 500 w.

*1918. Launch of H. M. S. Venus. Ill. (A detailed description of a second-class protected cruiser for the British government. Cuts of steering engine and gears). Steamship–Oct. 1600 w.

*1919. Engineering and Ship-building in the

We supply copies of these articles. See introductory.

Far East. William C. Jack (Paper read at meeting of Inst. of Engineers and Shipbuilders at Hong Kong. Setting forth the economic value of this institution in the Far East). Steamship-Oct. 1700 w.

*1920. Automatic Governor for Marine Engines. Ill. (Patented by Thomas Barnfather and Charles Kübler. Intended to be used as a regulator of the steam supplied in such a manner as to prevent "racing" of the engines). Steamship-Oct. 1200 w.

1968. Kerosene Yachts. J. H. Killey (A description of a kerosene yacht on Hamilton Bay, and general discussion of kerosene motors for yachts and launches). Can Eng-Oct. 800 w.

2007. The Invention of the Steamboat (From *United Opinion*. A letter from Capt. Samuel Morey, who propelled a vessel by steam some years before Robert Fulton and his associates, with brief account of his work). Eng-Oct. 12. 1500 w.

*2075. The Waste and Supply of Shipping (Statistics compiled from Lloyd's Registry presenting the debit and credit side of the shipping industry). Engng-Oct. 11. 1200 w.

*2076. Water-tube Boilers for Marine Use. James Howden (A critical examination of the advantages claimed for water-tube boilers in which the time named for getting up steam is held to be greatly over stated in favor of water tube boilers and a general exaggeration of the advantages is alleged). Engng-Oct. 11. 4500 w.

*2077. Belleville Boilers and the British Admiralty. Argus (A further criticism of the Belleville boiler in which the British Admiralty is charged with having adopted the boiler before they had carried out a single experiment with it, and severely denounced for its action in the matter). Engng-Oct. 11. 4500 w.

*2082. Water Supply on Board Ship (How a full water supply may be assured by the use of evaporators, with illustration and description of a distilling apparatus for this purpose). Eng, Lond-Oct. 11. 1200 w.

*2083. 6000-Ton Depositing Dock for Barcelona (Illustrated description). Eng, Lond-Oct. 11. 1000 w.

*2084. Shipbuilding on the American Lakes (Discusses the inevitable effect of the opening of the Canadian ship canal at Sault Sainte Marie; existing tonnage will become obsolete, and shipbuilders and marine engineers will reap the benefit of replacing it with ships of larger capacity). Eng, Lond-Oct. 11. 1500 w.

*2086. The Propelling Machinery of the Samoyed. Ill. (The ship was completed within three months from date of order. A set of indicator diagrams and a cyclogram presented in this article show that, notwithstanding this unusually rapid construction, her performance is very satisfactory). Eng, Lond-Oct. 11. 1000 w.

*2088. Marine Boilers (A criticism upon water-tube boilers for marine use exemplified by the behavior of the boiler on the new American liner, Paris). Eng, Lond-Oct. 11. 2200 w.

*2089. An Amphibious Boat (An illustrated description of a very curious boat, or railway car, or, better, an amphibian combination of car and boat, self-propelling for both purposes, which plies on two lakes near Copenhagen, and crosses an isthmus, 1100 ft. in width, each trip, and which since July 15th has made six trips daily, and carried 20,000 passengers). Eng, Lond-Oct. 11. 1000 w.

*2110. The Revival in Shipbuilding (Statistics showing a marked improvement during the past three months). Trans-Oct. 11. 900 w.

*2142 Marine Etiquette. A. Oscar Klaussmann (Translated from "Ueber Land und Meer." Sketch of international marine etiquette and its expense). Chau-Nov. 2200 w.

*2168. Depositing Dock at Barcelona (Illustrated description). Engng-Oct. 18. 800 w.

*2171. The America Cup (A discussion of the late yacht race between Valkyrie and Defender from a professional point of view. The Herreshoffs are given great credit as original designers, but English sail-makers are considered still superior to American). Engng Oct. 18. 2500 w.

*2172. The Strength of Cylinders. J. C. Spence (A theoretical discussion with an editorial criticism). Engng-Oct. 18. 3600 w.

†2192. Description of the Finlayson Marine Pipe Boiler. Arthur E. Blackwood (This boiler is a new claimant for public favor which has come into notice during the past year, and which has distinctive features worthy of study). Eng Soc of School of Prac Sci-No. 8. 1000 w.

†2271. Quick Transit between New York and London. Austin Corbin (Favoring the shortest possible route, which it claims would be from Fort Pond Bay, on the north side of Long Island, six miles from its most eastern point, to Milford, the most westerly port of Wales. Tables of comparative routes are given and time calculated. The advantages are shown, and its national importance explained). N Amer Rev-Nov. 5400 w.

2304. Stopping, Steering and Resistance of Floating Vessels. Joseph R. Oldham (Abstract of a report of a committee appointed to investigate the effect of reversing the screw of a vessel upon the action of the rudder). Sci Am Sup-Nov. 2. 2700 w.

2392. The Use of Current Meters in Marine Observations (Deals with difficulties met in the use of current meters in a seaway during a survey of the Gulf of St. Lawrence, and the method and appliances used in surmounting the difficulties. A very interesting paper on an important subject). Eng News-Oct. 31. 900 w.

2427. Engine of the Steam Yacht "Free Lance" (General features of design and arrangement). Am Mach-Nov. 7. 600 w.

2457. Corn-Pith Cellulose for Warships (A description of tests made by the United States Navy Dept. with corn stalk pith cellulose as a substitute for cocoa fibre cellulose for closing holes and excluding water from shot holes in warships). Eng News-Nov. 7. 900 w.

MECHANICAL ENGINEERING

Steam Pipes and Pipe Joints for Marine Use.

IN line with the subject of winding steam pipes and the testing of wound pipes, treated in this department for October, is the following abstract of an unsigned article on marine steam pipes and the making of joints therein, in *The Iron Age* (Oct. 24).

The author thinks the success of the recent introduction of steel pipes is yet problematical, although they appear, so far, to answer very well. Time is needed to develop the defects which, he thinks, may exist, and which may yet reëstablish the superiority of copper for this purpose. The difficulty of carrying high steam pressures in copper pipes is not ignored by this writer, but he thinks that, while attention is bestowed upon strengthening copper pipes, study should also be directed to the improvement of joints, which, he claims, are commonly faulty; and he follows this with good practical directions for making permanently tight joints.

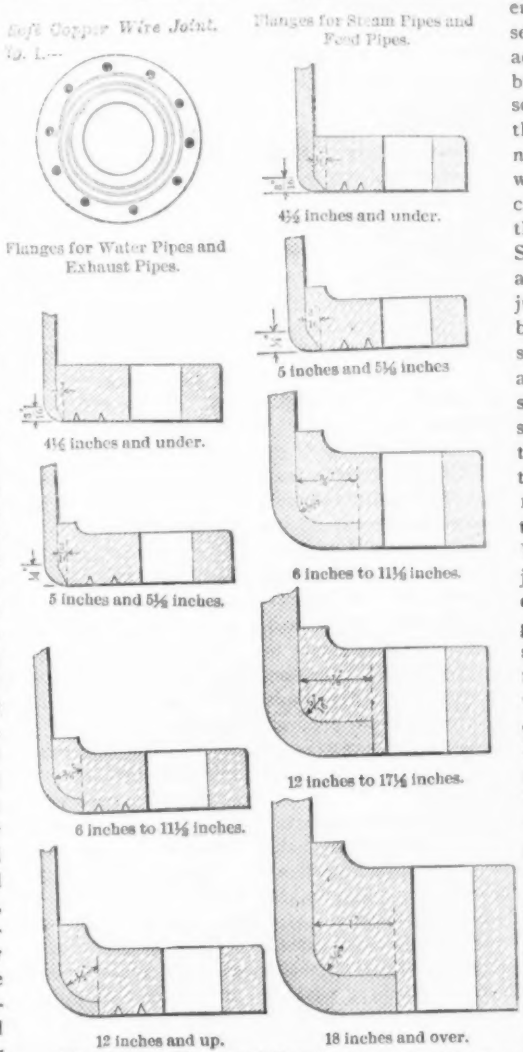
The flanges of copper pipes are usually of composition, and are secured by brazing. Brazed joints frequently give trouble, as ofttimes the work is so carelessly done as to burn the copper and destroy its tenacity. Indeed, the brazing on of a large flange can be intrusted only to the most skilful of coppersmiths, and is always attended by risk and uncertainty. It is always impossible to know exactly the extent of contact of the spelter under the boss of the flange, and it has become the best practice to counterbore the flange face heavily and to turn the pipe end completely into this recess, facing the end off to the facing of the flange surface. This adds greatly to the strength of the connection as well as to the tightness of the joint, and should always be carefully looked to, as the difference in expansion of the composition and the copper always tends to separate the flange from the pipe.

For making good joints the flanges must be, first of all, faced off. Rough and uneven surfaces, or those with surfaces warped or curved, will not allow a good joint to be made on them. After facing, the next point to keep in mind is that, the thinner the interposed material, the better for the durability of the joint. The day of thick gaskets has long since passed. In fact, there is no theoretical reason for any gasket whatever between faced flanges, but, in practice, unless the surfaces are ground together, there are little inequalities which prevent an absolutely perfect contact, and necessitate an elastic or pliable filling.

For standing or permanent lines of piping which do not have to be taken down for any work on adjacent machinery the very best joint is made with red lead and iron borings. The borings must be very fine, sifted through a fine wire gauze sieve, and then mixed with red lead putty, until the color is black and the consistency such as will allow it to be broken without bending. The surface of the flanges should be scored with one or more continuous rings, as shown on the sketch of flanges, and the putty applied in as even and thin a layer as possible. The joint is then set up as tight as the bolts will safely stand, and the putty is baked by putting a blank temporary flange on the open end of the pipe and turning on a very little steam. This baking process should be done with every joint before the next one is made, and the resultant satisfaction will amply pay for the time and trouble taken.

For other pipes, which are of necessity removed occasionally, a different joint is recommended. A sheet gum gasket used to be the only kind used, its ease of fitting and applying giving it many advantages; but the ordinary sheet gum, pure or cloth inserted, will not stand the tests of high pressures and temperatures, and, while there are many modifications of it admixed with graphite and other substances, they all have the fault of softening under heat and requiring the going over of all the

bolts of the flange after steam has been applied to the pipe. Where gum for any reason must be used, the kind to apply is the specially oxidized, which will not strip from the insertion. Better than gum, however, is the wire gauze and asbestos material now on the market, wherein strands of copper wire are first woven about with a web of long fiber asbestos, these wires then being woven into a wire cloth and the insterstices filled with a rubber paint. This should be used in the thinnest form, nothing thicker than $\frac{1}{16}$-in., for the best results. It is an almost perfect packing, and could be improved only by having the wires woven in spiral mesh instead of square. It is far better than the old wire gauze and red lead joint, as it is absolutely evenly filled, while the other joint frequently failed through having the lead lumpy or gritty and uneven. The best kind of joint can be made with simply soft copper wire alone. It is more difficult to apply, especially where the flanges are vertical, but its trial will be well repaid. The wire must be soft and uniform; the winding can be done on any mandrel, and the turns overlapped or spread out like a spiral spring compressed to one plane. The ends should be secured to their adjacent helix by a touch of solder only on the sides, and not where it will come in contact with the flange. Single and separate rings are just as good, but harder to space properly and hold in position before setting up, and the style illustrated in Fig. 1 is better for this reason. When hot, the joint is tightened by the greater expansion of the flanges and wire over that of the connecting iron or steel bolts. With this or the wire woven material above all, the smaller joints can be made absolutely tight, and the permanent joints made and baked as described can be relied on to stand for years without a weep.


Soft Copper Wire Joint. Fig. 1.
Flanges for Water Pipes and Exhaust Pipes.
4½ inches and under.
5 inches and 5½ inches.
6 inches to 11½ inches.
12 inches and up.
Flanges for Steam Pipes and Feed Pipes.
4½ inches and under.
5 inches and 5½ inches
6 inches to 11½ inches.
12 inches to 17½ inches.
18 inches and over.

Figs. 2 to 9.—Manner of Turning Over the Pipe Ends

It is a common occurrence to have leaks appear around the flange bolts while the flange joint is tight. This should not be,

as it shows that the part outlying the line of bolts is the best part of the joint. This fault is as bad as a leaky gasket, sometimes, owing to the difficulty in grummetting bolts in many situations. The whole effective joint should be embraced in the surface between the bolts and the pipe orifice; there is no more necessity for a very wide bearing than in the case of a seat for a conical valve.

Electric Welding—Another New Process.

QUOTING *L'Industrie Electrique*, the *Western Electrician* (Sept. 28) gives a description of the latest new process of electric welding, devised by Dr. Zerener, pointing out distinctions between the four principal processes now known. The following abstract of the article presents the main facts relating to the several processes.

Prof. Thomson's method depends upon the direct transformation of electric energy into heat energy at the point where the union is to take place. Alternate currents are used. The high temperature attained, because of the resistance offered, renders the metal soft and malleable, but a generator of high power is required, while the secondary current used must be capable of great intensity with very low voltage. Iron wires, cables, bars, rails, etc., may be welded by this process, but plates of considerable surface cannot be so well manipulated, because of the impossibility of covering the necessary space with the currents of the proper strength to produce the heat required.

In the process of M. de Bernardos the heat of a voltaic arc is utilized upon the article to be manipulated, this last being brought between the arc, which is the positive pole, and the negative pole, which is of carbon, in case the object is of iron or steel, and the reverse contacts being made for other metals. The current used is a continuous one, and may reach 1000 amperes.

In the process of Lagrange and Hoho the voltaic arc is not directly utilized, but heat is developed by resistance to current. The resistance is produced by a hydrogen medium surrounding the object to be treated, which is in a bath of water connected with the opposite electrode. This process is evidently unavailable for plane surfaces.

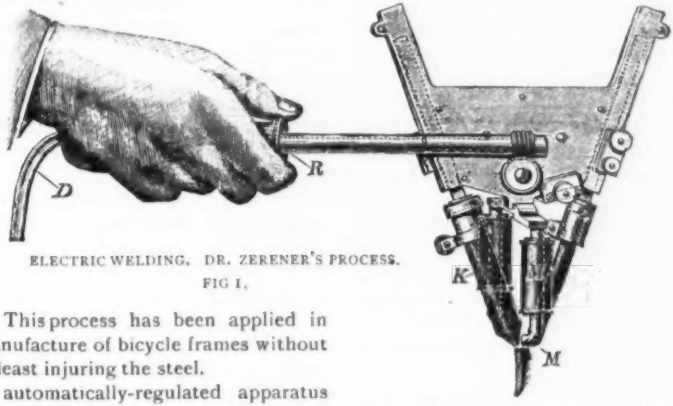
The limitations of application and the high currents required in each of these processes seriously impair their general usefulness, and from these objections it is claimed that the Zerener process is exempt. In this process the heat of the arc is utilized, as in the Bernardos system, but the two poles are two carbons, whereas in the Bernardos system the article becomes one of them. The distance secured by adjusting these permits a greater range of surface and regulates the intensity of the current, and the consumption of energy as well, while the metal is not consumed as part of the arc. An ordinary arc cannot be well utilized for heating purposes, without very closely approaching the object treated. Dr. Zerener has overcome this difficulty by arranging the two carbons in "V" shape, and submitting the arc to the action of a magnetic field developed by an electro-magnet, which forces the arc downward toward the angle of the "V." In these conditions the arc takes the form of a dart. This projected flame has a temperature nearly equal to that of the arc proper, and is readily available for welding.

In Fig. 1 is shown an apparatus designed for hand regulation, although larger ones have been made for automatic regulation. It is said that the weight of this apparatus is not over one kilogram. The arc is regulated by hand by turning the thumb-screw, *R*, forward or back, thus changing the length of the arc to suit the requirements of the case.

The spools, *M*, of the electro-magnet are branched in series with the arc, enabling the operator to obtain a pointed flame at will,—a flame of high temperature,—which can be directed immediately on the point of the metal where the junction is to be made. The wires, *D*, shown below the wrist of the operator, lead to the carbons as in an ordinary arc lamp. The apparatus is very effective with a minimum current of 15 amperes at 40 volts, and, when necessary, a maximum of 2400 watts may be reached. The apparatus may be used for

welding or brazing small pieces of iron, copper, silver, etc., without the intervention of any preparation.

When the current required for brazing reaches 40 to 60 amperes, a flux of borax is

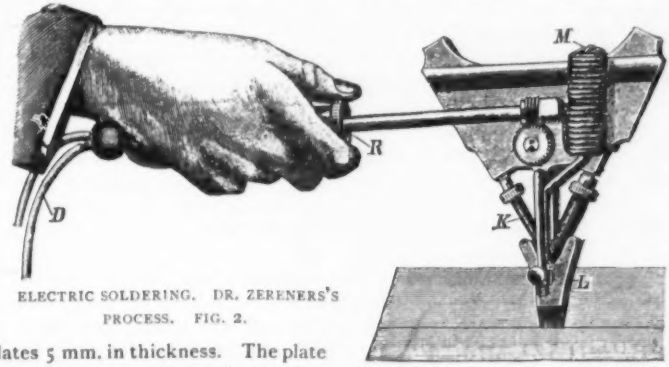


ELECTRIC WELDING. DR. ZERENER'S PROCESS. FIG 1.

used. This process has been applied in the manufacture of bicycle frames without in the least injuring the steel.

The automatically-regulated apparatus is built upon the same general principle. Constant potential current is used; the solenoid producing the field is excited in derivation with a current of 15 amperes. The arc absorbs 100 to 200 amperes with a difference of potential of 70 volts. This model is used for welding iron, and will weld plates 5 mm. in thickness. The plate is placed upon a piece of iron, the two lips to be welded being separated about 2 mm. The apparatus being thus disposed, the extremities of the carbons are held a short distance from the plate. With the aid of a spring support, a very feeble effort on the part of the workman suffices to graduate the distance from the point to be acted upon. Small pieces of soft iron are melted between the plates to be joined, and the junction is hammered smartly during the cooling process. The work is thus accomplished in sections of about 2 c m.

The employment of an arc between two carbons permits limitation and regulation of the consumption of current. An arc of 3 amperes and one of 200 amperes have the same temperature; it is only the quantity of heat disengaged that varies. According to the needs of the case the intensity of the current may be regulated,—a regulation which covers from the minimum of 3 amperes to a maximum of 200 amperes. The cost of the apparatus is less than that for either of the other methods. No accumulator is needed, and the current of an ordinary lighting or power plant may be used. Fig. 2 illustrates an electrically-heated soldering iron, to the copper bolt, *K*, of which the current is applied.



ELECTRIC SOLDERING. DR. ZERENERS'S PROCESS. FIG. 2.

The Horseless Carriage.

MR. PAYSON BURLEIGH, who seems to have given attention to the subject, gives some points to inventors of horseless vehicles in *The Age of Steel* (Oct. 12). First, it will be necessary to have steering gear by which such vehicles can be guided with no greater exertion than is now required to drive a horse. "Under the very best conditions," says Mr. Burleigh, "the driver will have to keep a closer watch than in driving a horse, because, when a horse is used, the business of guiding the vehicle is divided between two intelligences, that of the man and of the beast; and, when he is well trained, a good deal of it is left to the intelligence of the animal. It will be some time before the inanimate carriage receives the training which will allow it to be driven with a loose rein anywhere except on a tramway.

"The horse follows the crooks of a country road, but then the training of the 'motorcycle' (horrid name) will inevitably straighten out the crooks in the country road, and afford long ranges of straight tracks. The horse never blindly runs plump into another vehicle in the city streets. A mere touch of the rein, simply as a suggestion, is sometimes given, but a well-trained horse is often more capable of guiding himself than the best driver is capable of directing his course. In a dark night on a dangerous road—like some of those which skirt the sides of Californian mountains, where a misstep means a headlong plunge over a precipice—the human perceives that impertinence is too risky, and allows the noble steed to go as he will.

"When one takes out a self-propeller for a spin on the road, however, he has to find, not only the intelligence for the direction of his course, but also all the power needed to keep it or to change it. It may seem, at the first glance, that very little power is needed for this purpose, but a little reflection will show that there must be a constant expenditure of force, even to keep a straight course, because the resistance to one wheel is scarcely ever just equal to the resistance against the other, and just so much as it is greater, that much must be borne by some other power. If a stone, or a depth of sand, or anything else, obstructs the passage of one of the guiding-wheels, there is a tendency to push that wheel back,—or something equivalent to that,—and this tendency must be overcome, or the vehicle will deviate from its course."

An argument is then made to show that steering a four-wheeled vehicle by the leading wheels will permit shorter turning and consume less power than steering by the rear wheels.

The feature deemed next in importance is the brake mechanism, which must be certain in its action and readily manageable. If this class of vehicle is to become widely popular (and Mr. Burleigh thinks this seems to be assured), "it must be so easily managed that a lady can take it out to go for an airing with no more trepidation or anxiety about steering it than she feels in handling the reins."

Mechanical and Unmechanical Devices.

THESE terms, used very vaguely by mechanics in general, are made the subject of an article by Mr. Frank Richards in *American Machinist* (Oct. 24), and an attempt is made to define them. Some devices in common use in shops are also criticised as unmechanical, and lines of improvement are indicated. Mr. Richards says:

"The most mechanical device or system is that which, all things considered, is best adapted to the accomplishment of the proposed result. A very common expression of condemnation employed by practical mechanics regarding devices which challenge their judgment is that they are unmechanical, and we usually find that the idea meant to be conveyed is that they are not the best that could have been employed for the purpose. There are mechanics who regard some devices as more mechanical than others, independently of the place and mode of their employment. Mechanics generally dearly love toothed gearing, and are slow to condemn its use anywhere as unmechanical; but gears may be out of place sometimes, just as much as toggle joints or sprocket wheels and chains

may be out of place, and therefore may be unmechanical. The mechanical device is usually the simple device, but it is not always and necessarily true that the simplest is the most mechanical. Simplicity in everything mechanical can scarcely be overrated, but the lasting or slow-wearing property may be of first importance in some cases, and this may be sometimes promoted by a little more complexity of device. If it can be shown that serious and constant wear is involved in the employment of a certain mechanism, and that this wear might be mostly avoided by the employment of another device of the same, or but slightly-enhanced, cost and complexity, then the first must be condemned as the unmechanical one. The term mechanical or unmechanical can never be employed for sentimental or traditional reasons, but only in view of results accomplished. Nothing, if it will work at all, is, unmechanical, until a better device can be found to supersede it. Fault-finding has its only justification in the suggestion of something better."

Designing Machines.

AN editorial in *American Machinist* (Sept. 12) says some sensible things on the subject of designing machines. It attributes "much of the crudeness apparent in machine designs . . . . to the fact that the art of designing in iron is yet in its early and formative stages," which sounds rather queerly when we reflect that the use of iron dates back to a prehistoric period. That "there are few who clearly see what is appropriate and what is inappropriate" may be admitted. Our contemporary thinks only two styles yet evolved "that deserve to be perpetuated. The hollow pedestal may be taken as the "type of one of these and the I-beam of the other. A machine having all its parts in one or the other of these will be harmonious in its style, though it may be illy-proportioned and lack grace of form; but a design that mixes the two in one machine can be but a mongrel, no matter how meritorious it may be in other respects." The article is, in the main, a criticism of the impropriety of applying architectural ideas to machine designing, and appears to have been called forth by an absurd design for a type-writing machine recently put upon the market, which design, an advertising circular states, was executed by an architect of some note in connection with one of the buildings erected at the late World's Fair at Chicago. The secret of machine designing is almost unveiled in the following quotation.

"There are a number of frightfully ugly typewriters on the market, but there are also some very neat ones, and in every case the ones that are most pleasing in appearance will be found to have frames designed in harmony with the material of which they are made and for the evident and sole purpose of effectively supporting the working parts of the machine in their proper positions."

Adaptation to the exact working requirements without excess of material at any point is the secret of good machine designing. Parts designed to have greatest strength when applied to a given purpose with the minimum of material are nearly always graceful in form. The hollow pedestal and the I-beam spoken of above are examples, if designed on the principle enunciated. Simmered down, we find this principle to be maximum utility wedded to economy of material.

In nature,—as in the trunk of a tree, with its graceful curves outward toward the roots and its upward taper, or in the shell of a bird's egg—this principle is carried out to the utmost extent.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Technical Journals—See Introductory.

The Machine Shop.

2129. The Construction of the Teeth of Gear Patterns. Ill. Isaac Whitehead (Discussion of a method proposed by Mr. Dingey and a description of another method). Am Mach-Oct. 17. 1300 w.

2130. Conference on Unification of Methods of Testing Materials of Construction. Gus. C

We supply copies of these articles. See Introductory.

Henning (Progress in the work of the committee—yet far from conclusion—is reported. Questions discussed and conditions proposed are given). Am Mach-Oct. 17. 1500 w.

†2183. Vice Work. G. M. Campbell (The subject is treated in a broad manner as including all operations not performed by machine tools. Illustrations of tools for clipping, filing, scraping, polishing, etc., with illustrated description of appliances for holding work, etc., are given). Eng Soc of School of Prac Sci-No. 8. 6000 w.

†2188. The Cleaning and Annealing of Castings. H. L. McKinnon (Describes various processes for improving the appearance and quality of iron castings, such as pickling, annealing, rolling, etc.) Eng Soc of School of Prac Sci-No. 8. 2300 w.

†2190. Hardening and Tempering Steel. E. F. Shipe (Discussed wholly from the standpoint of the workman in the shop, and therefore of practical importance to all who have hardening and tempering to do. The work of hardening and tempering is divided into three classes, viz., tools, etc., in which only a part is to be hardened and tempered, those which are hardened all over, and dies, tools and parts of machines required to be as hard as possible. Each class is treated seriatim and practical suggestions are given). Eng Soc of School of Prac Sci-No. 8. 3000 w.

†2191. Gear Cutting. H. V. Haight (The different styles of gears are first considered and they are divided into four classes, and this is followed by descriptions of methods calculated to secure the highest degree of perfection in cut gears; the text illustrated by numerous diagrams). Eng Soc of School of Prac Sci-No. 8. 3300 w.

2283. Some Historical Notes Relative to the Invention and Development of the "Slide Rest." Ill. W. F. Durfee (The author has here brought together a great deal of interesting information). Am Mach-Oct. 31. 2500 w.

2284. Design for a V-Threading Tool—Lead Lapping. A. H. Cleaves (The tool described is intended for the performance of small work on a large lathe in cases where a smaller lathe is not at hand). Am Mach-Oct. 31. 1800 w.

2331. Modern Milling Machines. Ill. (A general review of the principal milling machines now in use, with notes of individual merits and special adaptations for different kinds of work). Mach-Nov. 3600 w.

2332. Some Notes on Upsetting Steel. Boyd Harriman (Practical observations by an expert tool-dresser, containing valuable hints). Mach-Nov. 1000 w.

2333. Measuring Angular Work. J. T. Giddings (Discusses pleasantly and profitably, instruments and methods for the purpose named). Mach-Nov. 1300 w.

2334. Steel Riveted Steam Pipe. James Anderson (Criticises the application of boiler methods to the making of this class of pipes as being faulty, and then proceeds to describe and illustrate the proper method. A table is appended, giving port area, port width, and steam pipe diameter for various piston speeds and steam velocities). Power-Nov. 500 w.

*2343. Rivets and Riveting. G. R. Bale (Discusses material of rivets, different forms of rivets, tests both for ductility and bending, proportions of rivet heads tabulated for different sizes and machine riveting versus hand riveting) Prac Eng-Oct. 25. 1500 w.

*2360. A Chuck for Screwing in Stay Bolts (Describes and illustrates an ingenious and useful implement invented by Mr. L. Bartlett, Master Mechanic of Missouri Pacific R. R., and now used in shops under his charge. It is used in connection with a steam or air-driven motor). Nat Car & Loc Build-Nov. 600 w.

2428. Reamers—Countershaft—Hangers—Projection of Drawings—Monkey Wrenches. Oberlin Smith (Discussion of practical questions relating to the appliances named). Am Mach-Nov. 7. 2000 w.

2429. Sectional Dies. J. L. Lucas (The advantages of sectional dies, if the dies be of large size, or of difficult shape; construction of compound dies illustrated by a diagram). Am Mach-Nov. 7. 800 w.

Steam Engineering.

1967. Steam Boiler Explosions. A. E. Edkins (General considerations and an account of personal experiments, inspection, etc.) Can Eng-Oct. 5000 w.

*1974. Boilers and Feed-Waters (Editorial. General discussion of principles, and an argument favoring the pumping of feed-water into steam space, instead of below the water line, as resulting in greater durability and lessening needed repairs). Eng Lond-Oct. 4. 1900 w.

2000. The Tubular Boiler (A good boiler to invest in when properly designed and carefully made and set up). Bos Jour Com-Oct. 12. 1000 w.

2008. Effect of Fire on Boiler Plates (In favor of water-tube boilers. Experiments of Dr. A. C. Kirk). From the *Indian Textile Journal*. Eng-Oct. 12. 1300 w.

*2028. Boiler Explosions Ill. W. H. Fowler (Paper read before the Inst. of Civ. Eng. The subject dealt with in its broad engineering aspect, with brief reference to old theories). Prac Eng-Oct. 4. Serial. 1st part. 3300 w.

*2052. On Condenser and Receiver Drop. A. C. Elliott (Mathematical and thermo-dynamic discussion, the object of the paper being (a) to point out in the first place, why condenser and receiver drops are necessary; (b) to inquire with regard to certain economical considerations what amount of drop should be allowed as a minimum; (c) to discover the effect of drop on the quality of the steam subjected to it; (d) to find whether in a particular cylinder any part of the power lost by receiver drop is recovered in the next cylinder, and if so, how much; and (e) to develop the thermo-dynamical equations for compound engines of two or more stages, taking account of drop). Engng Oct. 4. 2500 w.

*2059. Continuously Registering the Performance of Winding Engines, with Observations on Steam Expansion M. Griot (From a communication to the Société de l'Industrie Mineral, Saint Etienne. An exceedingly able paper,

naming conditions to be fulfilled by expansion in winding engines, with experimental methods of studying these conditions, and practical applications of principles to the fulfillment of the conditions). Col Guard–Oct. 4. 6400 w.

2127. Cylinder Oils and Oil Experts. W. E. Crane (Qualities needed in cylinder oils, and experiences with various kinds, good and bad). Am Mach–Oct. 17. 1100 w.

†2186. Hirn's Analysis of Heat Distribution in the Cylinder of a Steam Engine Edgar J. Laschinger (This analysis is discussed in relation to important additions to Hirn's investigations made by Zeuner, Major English, and Mr. Bryan Donkin, and with reference to increasing economy of steam in practice). Eng Soc of School of Prac Sci–No. 8. 2500 w.

2329. Angularity of Connecting Rods. Theo. H. Scheffler, Jr. (An adaptation of Zeuner's well-known diagram whereby the angularity of the connecting rod is taken into account in locating the point of cut-off). Mach–Nov. 400 w.

2330. The Inertia Governor. J. Begtrup (An analysis of the action of this class of governors and a discussion of the mechanical principles involved in their operation). Mach–Nov. 2400 w.

2335. A New Method of Heat Transmission (Describes an interesting new departure in the construction of steam boilers, in which instead of heating the steam generating water directly by application of the heated gases of combustion applied to the water containing compartments, the gases of combusion are utilized in superheating steam in tubes which run into the water space and thus convey heat to the water. The construction of the boiler is illustrated by a diagram and an account of tests is also given). Power–Nov. 2500 w.

2336. Bursting Strains of Fly Wheels (Principles involved are illustrated by diagrams and formulæ for the easy computation of the strains are supplied). Power–Nov. 1000 w.

*2400. A New Theory of the Strength of Boilers. J. C. Spence (Mr. Spence says that "starting from the hypothesis that the shell of a boiler in transmitting pressure to its ends acts as a hollow cylindrical beam which must be treated as a continuous whole and not as a set of disconnected staves, my own conclusions are that the bending moment in any direction at any point in the beam is balanced by an equal bending movement acting at the same point but in the opposite direction; that the pressure which is transmitted to the ends is transmitted by a series of shearing stresses, increasing from nothing at the center to a maximum value at each end; that the amount that can be so transmitted is limited by the resistance of the shell plate to shearing through at the ends"). Eng Rev, Lond–Oct. 21. 2400 w.

2431. Some Threshing Incidents (The statements as to the altogether remarkable carelessness, recklessness, ignorance and obstinacy of the agricultural population in Minnesota and Dakota are almost incredible. The experiences of an insurance inspector among these people are recounted). Sta Eng–Nov. 1300 w.

Miscellany.

*1889. Aim and Scope of Schools of Mechanical Engineering. R. H. Thurston. Eng Mag–Dec. 2000 w.

*1891. Opposition to Inventions. William C. Dodge (Showing by numerous examples the disposition to discourage inventors). Eng Mag–Dec. 3000 w.

*1892. The Value of Manual Training Schools. Ill. A. E. Outerbridge, Jr. (Discussed in the light of methods employed and results achieved at Philadelphia). Eng Mag–Dec. 2300 w.

*1895. The Bearing of Machine-Shop Experience. Charles E. Emery (Discussing the question of how far and in what order instruction at technical schools should embody practical York). Eng Mag–Dec. 2400 w.

1914. Welding and Forging Steel. Ill. (The illustrations were taken from the plant of the Benjamin Atha and Illingworth Co., Harrison, N. J. Descriptive of process). Sci Am–Oct. 12. 900 w.

1956. Strength of Boilers (The best shape to withstand pressure is probably the sphere; the next best the cylinder. The strength depends upon the tensile strength of the iron or steel, the thickness of the shell, the strength of the riveted joints, and the diameter of the boiler. How to figure the strength). Lord's Mag–Oct. 2000 w.

1957 Wastes of Heat (The causes of waste considered). Lord's Mag–Oct. 2000 w.

*1984. The Manufacture of Costly Steel Instruments. Thomas Morris (Abstract of paper read before the South Staffordshire Inst. of Iron & Steel Works Managers. The extent to which labor adds to the value of crude material in its conversion into articles in common use is most strikingly shown in this interesting paper.) Ir & Coal Tr Rev–Oct. 4. 4000 w.

1993. India Makes a Step in the Right Direction (An exhaustive article regarding recent changes in the patent laws of India. It is proposed to make radical changes in the old law which will prove of interest to inventors and patent agents). Inv Age–Oct. 2500 w.

2001. Hydraulic Elevators (A test to ascertain their economy, with table of general results). Bos Jour Com–Oct. 12. 800 w.

*2033. Deflections and Strains in a Flexible Ring Under Load. William H. Searles (Flexible ring of uniform section standing. The following inquiries are answered mathematically by formulas deduced from known data. What load will be required to produce a given depression? What will be the horizontal extension of the ring under the same load? What is the relation between the vertical and horizontal displacements? What is the general relation between loads and vertical depressions? What are the principal moments of resistance at the side and top? What is the position of the section of no moment at any period of deflection? What is the radius of curvature at the side or at the top under any condition of load or depression, and at what point of depression does the radius of curvature become

infinite? Again the same questions arise if we suppose the load to be replaced by a vertical pull, changing the ring from a roller into a link). Jour Asso of Eng Soc-Sept. 3200 w.

*2049. Butter Manufacture. Ill. (Description of new Swedish power churn which separates the butter from the cream almost instantaneously). Engng-Oct. 4. 1500 w.

2131. Training the Untrained Horseless Carriage. Payson Burleigh (Points out that the feature of automotors that will require most attention is the Steering gear. Next in importance will be the brake). Age of St-Oct. 12. 1500 w.

*2141. The March of Invention. N. S. Shaler (Concerning the channels in which invention has run, showing how science and mechanical skill have improved the condition of civilized man). Chau-Nov. 3200 w.

2143. Units of Force and of Mass. G. A. Goodenough (A criticism upon a previous article in *American Machinist* on this subject, and an explanation of the proper meaning and use of these units in mechanics). Am Mach-Oct. 24. 2000 w.

2144. Unmechanical Devices. Frank Richards (What is meant by mechanical and unmechanical devices. A criticism upon some devices in common use in shops). Am Mach-Oct. 24. 1400 w.

*2164. Self-Propelled Road Carriages at Tunbridge Wells (An account of self-propelling vehicles exhibited at an agricultural show in which the types are pronounced good, but the opinion is expressed that much better ones are possible). Eng, Lond-Oct. 18. 1100 w.

*2167. The Serpollet Steam Road Carriage. Ill. (Detailed description. First number discusses difficulties of the problem, fuels for self-propelled carriages and the steam generator used by M. Serpollet). Engng-Oct. 18. Serial. 1st part. 2800 w.

*2169. New Saw-mill at Gloucester (Illustrated detailed description. Three full page sheets of drawings of details). Engng-Oct. 18. 1500 w.

*2173. Horseless Carriages at Tunbridge Wells (Illustrated description of the vehicles exhibited and of their performance). Irm-Oct. 19. 1200 w.

2180. Producer Gas in the Production of Power. W. J. Taylor (A letter giving some interesting views and notes on the advantages of gas engines, stating that they consume but half the quantity of coal required by a steam engine). Ir Age-Oct. 24. 600 w.

†2185. Aerial Mechanical Flight. C. H. Mitchell (This paper deals exclusively with the latest branch of aeronautics, aviation or mechanical flight, its history, aims, designs, and possibilities, taking the ground that engineers should at once make themselves sufficiently familiar with it to be prepared for its actual development considered to be assuredly not far distant. Discussion. Numerous cuts and diagrams illustrate the text. A very interesting and instructive paper). Eng Soc of School of Prac Sci-No. 8. 19000 w.

*2219. Horseless Carriages. David Salomons (Their early history, the relation to laws of the road, modern developments and probable results are dealt with in the first number). Prac Eng-Oct. 18. Serial. 1st part. 3200 w.

*2252. Stone Sawed Like Wood (A description of the work done by the Peckover improved stone saw). So Arch-Oct. 600 w.

2254. Local Annealing of Hard Faced Armor Plates. Ill. Hermann Lemp, Jr. (Abstract of paper read before the Amer. Inst. of Elec. Eng. A description of the process and apparatus necessary. Experiments described, and methods formerly used explained). Elec Eng-Oct. 30. 2800 w.

2282. Some Speculations Regarding Rapid Transit. Ill. John Brisben Walker (A consideration of the interesting problem of rapid transit, with the effect it will have on nearly every relation in life. Predicting that it will revolutionize our methods of living, and have an important bearing upon questions political and governmental). Cos-Nov. 2000 w.

2350. Indicator Rigging for Locomotives. Ill. (Description with diagram giving the dimensions of the indicator rigging employed on the Flint and Père Marquette locomotives). Eng & R R Jour-Nov. 1. 500 w.

2351. Rope and Belt Transmission. V. Dubreuil (Abstract of paper read before the Society of Civil Engineers of France, covering in a comprehensive manner the conditions most favorable for rope transmission). Eng & R R Jour-Nov. 1. 900 w.

*2356. Observations on the Lille Experiments on the Comparative Efficiency of Ropes and Belts for the Transmission of Power. David S. Copper (Abstract of important paper read before the Inst. of Mech. Eng., London. Gives tabulated results of experiments named in title, with general description of the arrangement of the machinery, a résumé of previous experiments and general remarks). Ind & Ir-Oct. 25. 3000 w.

*2413. Rotary Flour Bolts (Describes and illustrates the McAnulty Rotary Sieve Bolt and discusses its operation at length). Am Miller-Nov 1. 2000 w.

*2414. Bolts and Bolting. Alex. Dobson (Describes a very interesting series of finally successful experiments designed to improve the effectiveness of bolting reels). Am Miller-Nov. 1. 1800 w.

2426. The Kane-Pennington Motor. John Randol (An illustrated description of one of the most remarkable oil motors yet produced. The statement is made that 4¾ h. p. are obtained from an engine weighing only 17½ lbs., running at a regular speed of 700 turns per minute). Am Mach-Nov. 7. 3300 w.

2430. The World's Injustice to the Technical Man (Address of Mr. George W. Dickie before the Technical Society of the Pacific Coast, at an informal meeting held at San Francisco, Oct. 5). Am Mach-Nov. 7. 2000 w.

†2449. Our Unsatisfactory Patent System (Editorial criticism). Ind Rub Wld-Nov. 10. 900 w.

We supply copies of these articles. See introductory.

MINING & METALLURGY

Is an American Mining Boom in Sight?

THE question seems settled as to the growing interest in American gold mines. There has even been a mild effort to "boom" mining shares in the smaller cities, but all eyes are turned expectantly to South Africa, waiting to see what will happen. In order to show the comparison between some of our mines and the subject of the "Kaffir" speculation, *Bradstreets* (Oct. 26) quotes from the Denver *Republican:* Johannesburg (S. A.) "is producing about 260,000 tons of ore monthly, representing a gold output of about $3,000,000. The average value of the ore rarely exceeds $12 per ton, and the richest ore is about $25 per ton. The Cripple Creek district is producing about 15,000 tons of ore monthly, with a gold output of about $900,000 a month, the ore averaging $65 per ton. The Johannesburg ores are treated by stamp mills, and the tailings are then subjected to the cyanid process. The district has reached its development after enormous expenditure of capital and nearly 10 years of development. Without the aid of any outside capital, Cripple Creek has within three years reached a production one-third of that of South Africa. When the time comes for the enormous deposit of low grade ore at Cripple Creek to be treated any way near as cheaply as the cost at Johannesburg, Cripple Creek, the *Republican* claims, will produce more gold than Johannesburg. . . . . For several years past the efforts of prospectors have been directed to making discoveries of gold. The results of this activity are seen in the increase of the country's gold production, which for 1894 is estimated by the director of the mint at $39,500,000, as against $33,000,000 in 1892. The basis is certainly here for a development of the gold-mining industry of the United States with the aid of capital drawn from the public." A "crash in Kaffirs" does not seem imminent, though they will find their level in the near future, and, public confidence being reassured, capital will undoubtedly flow to enterprises as profitable as legitimate gold mining has become.

The Kaffir Craze.

SPECULATION in South African mining stocks is at its ebb. Not only has British capital poured its millions into these ventures, but French and German capital, followed by the Swiss and the Austrian, has gradually caught the fever, so that many of the most popular shares are sold ridiculously far above their possible value. Notwithstanding the enormous interests involved, says *Bradstreets* (Oct. 19), "accurate information relating to the ore deposits and the methods of working have remained very inadequate." The early mining, beginning about 1869, was confined to rich pockets in the outcrop, and it was some time before it was discovered that the conglomerate was the ore-bearing rock and the real ore.

"The Witwatersrand gold-bearing rock is remarkable for its enormous extent and wide distribution. The geological formation is made up of sandstone, quartzites, shales, schists, etc., among which occur a number of beds of the conglomerate in which the gold is found. These reefs are, in some cases, found only a few hundred feet apart, and vary very much in thickness. Six of them are clearly defined, and have been located for miles. They consist of masses of water-worn pebbles fused, and have apparently been tilted up through the upheaval of intrusive masses of diorite formation, dykes of which penetrate the country, intersecting the gold rock and producing in the latter a large number of faults and breaks. The strata in which the gold is embodied tilt up from the north and dip toward the centre of the basin, flattening at angles from 80° to 10°. The basin is, so far as traced, some 130 miles long by about 30 miles wide, the irregularities already referred to not being

sufficient to prevent its extent being delineated with considerable accuracy. The various beds of conglomerate are parallel to each other, and, while the seat of the principal mining is along a line 36 miles in extent close to Johannesburg, the line of six separate parallel reefs has been traced for 135 miles between Klerksdorp and Heidelberg, and is being worked in parts. The ore is what is described as 'free milling' down to the water line, or about 150 ft. deep, and amalgamates with ease on battery plates. At that depth it changes to pyrites and sulphurets, and can only be treated by the chlorination process. . . . The district, it must be admitted, is the greatest gold-producing region yet discovered. The total output of gold has been 6,538,393 ounces, which is about equal to $110,000,000 in value." The production of gold in 1895 will probably be $41,000,000.

"It will thus be seen that there is a basis for the exploitation of the district. It is the unjustifiable lengths to which the speculation has run that creates a dangerous situation. . . . According to a table in the London *Economist*, out of 131 mining companies operating in South Africa, most of them in the Witwatersrand, only 25 are dividend payers." The table is here given:

	Capital.	Market price.	Market price. Av. p. ct.
Dividend mines.....	$32,773,635	$192,822,000	588
Non-dividend mines.	138,649,770	569,145 230	408
Total mines	$171.423,405	$758,967,230	443
Trust, etc., Co 's	79,363.395	317,895,890	401
Totals.....	$250,786,800	$1,076,863,120	429

The following facts are quoted from an exchange showing the amount of inflation "in the 'Kaffir' market. The £1 shares of the City and Suburban Mine sold in September for £27, or 2700 per cent., while Simmer and Jack sold at 2175 per cent., Fereira at 2050, Crown Reef at 1200, and so on. Even more dangerous is the inflation in the unproductive companies. Most of these are 'deep-level' mines, which have before them an enormous expenditure ere they can become productive. An instance is given of the Rand Mines, the £1 shares of which sold at £38¼ or 3825 per cent. Altogether, the nominal capital of these concerns, reduced to our money, is $138,000,000, which at the market price had a speculative value of $566,000,000, or over 400 per cent. of their par." At least twenty-six trusts intended to hold stocks or to finance mines have been formed in addition, and we have the following remarkable summary.

	—Capital stock—		Dividend %		Return on
Companies.	Par value.	Selling price.	Year 1894.	Half year 1895.	selling price.
City & Suburban	$ 425,000	$11,475,000	50	75	5.5
Crown Reef.....	600,000	7,200,000	50	25	4.1
Durban-Roodepoort	625,000	5,468,750	60	30	6.9
Ferreira.....	450,000	9,225,000	150	65	6.3
Geldenhui's Estate	1,000,000	6,937,500	30	30	8.8
Geldenhui's Main Reef ..	750,000	1,230,000	..	10	12.3
Glencairn	1,125.000	4 992,000	12½	15	6.8
Jubilee.....	250,000	2.687,500	120	60	11.5
Jumpers.....	500,000	4,375.000	55	25	6.0
Kleinfontein	925,000	5,435.000	12½	12½	4 3
Langlaagte Estate.....	2,350,000	15,860,000	45	25	7.5
May Consolidated.....	1,262,500	4,853.000	..	10	5.1
Meyer & Charlton...	425.000	3,135,000	55	25	6.0
New Chimes	500,000	1,625.000	25	45	27 8
New Heriot....	443,750	4,881,250	40	90	16.3
New Primrose.....	1,393,750	10,800,000	40	25	6 5
Nigel.....	1,000,000	7,625.000	50	20	5.3
Orion	800,000	3,250,000	105	20	8.8
Robinson	13,750,000	30,593.750	10	6	5 5
Roodepoort United.	750,000	5,906,250	20	25	6.3
Simmer & Jack	1,250,000	27,187,500	30	20	2.0
Stanhope	170,000	262,500	100	30	40.0
Transvaal Gold	1,300,000	12,510,000	10	10	2.1
Wemmer.....	275,000	3,095,000	..	100	17 5
Worcester	453,635	2,211,500	70	30	6.3
Totals....	32,773,635	192,822,000	..	35.9	61.

"As the average expense of working the largest and best conducted mine is 70 per cent. of the output, it can be seen that the capitalization is in excess of the results, and that the speculative value outruns all reason."

Aluminum Solders.

OWING to the difficulty of soldering aluminum satisfactorily, its application to the more finished work in the arts has been retarded. The difficulty arose in securing a solder that would attach itself to the metal, and this difficulty formed the basis of remarks made by Mr. Joseph Richards before the Franklin Institute, an abstract of which appears in their *Proceedings* (Nov.). In describing his own experiments, he "proceeded with the object of finding, if possible, a solder which should have the following qualifications: (1) it must wet the aluminum and adhere firmly; (2) it must not disintegrate after exposure to the air; (3) it must be as malleable and strong as aluminum; (4) it must have a low melting-point, so as to be easily worked with a soldering-iron; (5) it must have the same color as aluminum and not change color; and (6) it must be cheap enough for general use. After experimenting for about 2 years, it was finally found that an alloy of zinc and tin in certain proportions, containing a little aluminum and some *phosphorus*, realized almost every qualification." On fusing this first solder, it was found that a less fusible alloy liquated off. Supposing this to be the more stable alloy, having a formula expressed very closely by $Sn_4 Zn_3$, the solder now used was made accordingly, and is given below:

	Original Solder	Found in the liquated alloy	The formula $Sn_4 Zn_3$ calls for	Solder, as now made, contains	
Aluminum	2.38	.....	..	2.38	Zinc + aluminum, 28.57 p. c.
Zinc	19.04	.....	29.3	26.19	
Tin	78.34	71.65	70.7	71.19	
Phosphorus	0.24	.....	..	0.24	

"Though this solder is in use in both Europe and America, it must be remembered that at present the demand for an aluminum solder is limited. About 4 tons of aluminum are now produced daily in the world, but fully 75 per cent. of this is used up in the steel industry and in making alloys; while, of the remaining 25 per cent., which is rolled, spun, cast, or stamped into pure aluminum articles, probably not 10 per cent. is in such shape as to require soldering. Assuming then an average of 200 lbs. a day of aluminum articles to be soldered, a daily supply of a very few pounds of solder would meet the entire demand."

A Flume Coal Conveyor.

THIS novel form of coal conveyor, which transports small coal 8400 ft. from the washer to the coke ovens 1000 ft. lower in elevation, is now in operation at Horr, Montana. The Montana Coal and Coke Co., which operates the mines, found tramways and inclines too expensive when of sufficient capacity, and hope to save in a few months, by this new method, the entire cost of construction of the flume. Mr. B. L. Lloyd very entertainingly describes the conveyor in *The Colliery Engineer and Metal Miner* (Oct.), explaining the difficulties in location and construction. "When the writer ran the levels, he found that there was 128 ft. fall from the coal washer to the track at the first 'divide,' which is at the end of the first tramroad and the head of the first incline. This gave him a minimum gradient of 2.8 per cent.," which was consequently the minimum on the whole course. "Of course, when following the minimum grade, we took the best alignment we could get without too much grade work. It was side-hill work. We excavated, on an average, enough room for the boxes to rest on solid ground, making about half a dozen through cuts and putting in about a dozen small trestles. . . . . The boxes were made of undressed 2-in. fir plank, having 8-in. bottoms and 10 in. sides, thus giving an 8×8 in. opening. The sides were spiked to the bottoms with 30-penny wire nails, which were put at intervals of about 6 in.; collars of 2×6 in. plank were fitted with

some care at each joint, and were put around the boxes at the centre to keep them from warping or twisting. The planks were in lengths of 12, 14, and 16 ft., —mostly 14 ft.,—and were usually cut in two, making short lengths to go around curves. The joints could not be better. It was calculated that, while at first a very little water might leak at the joints, they would soon fill up with fine coal, which was found to be the case, the flume not leaking at all now. The trestles, not being in any place very high, were built of 4 × 4 in. lumber, with simply a cap piece 4 ft. long and two batter posts, which were clapped into and 'toe nailed' to the cap piece. Where trestles occur, it is intended to box in the flume with boards and fill in with saw-dust. The other portions will be filled around with earth and covered with boards.

"The flume has almost exceeded our expectations. It is working beautifully. It carries over all the coal that is put into it without cost, except interest on its construction." The coal is freed from water at the terminus by running the flume into settling tanks arranged in pairs, as then one can thus be emptied while the other is filling. These four tanks are built in pairs over the drying bins, 6 ft. wide and 6 ft. deep, and the same length as the bins. "When the first tank fills and the water first overflows, it is perhaps one-third full of coal, the water there overflowing carrying with it, in suspension, very fine particles of coal, almost as fine as flour, settling in the second tank." This fine coal makes good coke. The coal, after draining and drying, is converted into coke by the company's ovens, and used by Montana and Idaho smelters. The author concludes by explaining that "the flume, on all except the minimum grade, was lined with sheet iron to prevent wear. It seems to be something like the 'Kodak'; you put in the coal, and the water and the flume do the rest." They also contemplate the erection of a larger flume to convey the lump coal.

Electrical Mine Haulage.

ERNOCK COLLIERY has been in operation for 15 years in the coalfields of Lanarkshire, Scotland. The deposit worked includes five seams, and all haulage was done formerly by means of steam engines, horses, and self-acting inclines. The *Canadian Mining Review* (Oct.) abstracts the following in relation to it from the *Proceedings, Institute of Civil Engineers*. "Taking the present output by the two electrical hauling engines at 600 tons in 10 hours, it is estimated that, even if the same work could have been done by horses, it would have required forty horses and forty men, in addition to those now employed at the working face, to do the same amount of work. The annual cost of working with forty horses is therefore:

Depreciation and renewal of 40 horses 15 per cent. of £1200	£ 180
Keep of 40 horses, £30 per annum...	1200
Wages of 40 men, 5s. 6d. per day for say 250 days.....	2750
Total..... .. .	£4130

"The annual cost of working and maintaining the electric installation replacing horses is:

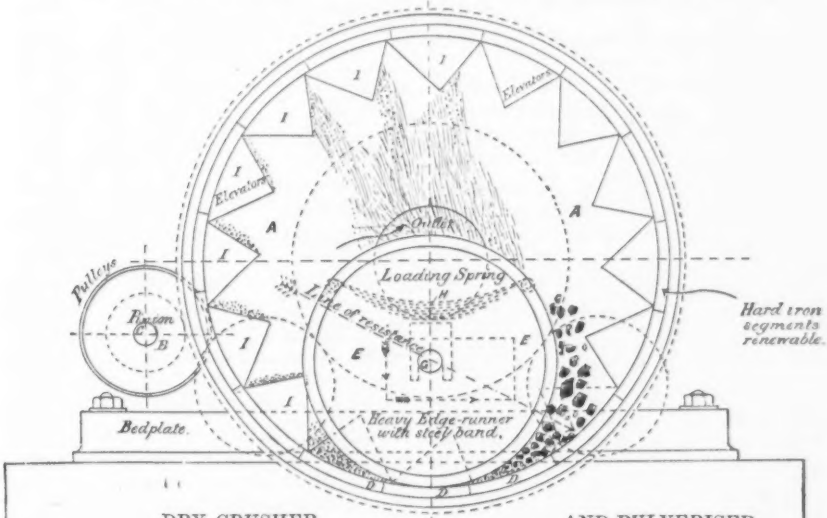
One electrical engineer 10s. per day for 250 days.....	£125
Twelve men at 6s. per day for 250 days	900
Coals, oil, stoves, etc.....	500
Upkeep and depreciation :—	
Building, say 5 per cent.....	30
Machinery, pulleys, ropes, etc., 15 per cent. on £2900.....	435
Total.....	£1990

"Deducting the cost of working and upkeep of the electric-haulage plant from the estimated cost of doing similar work by horses shows the substantial saving of £2140 per annum to be effected by the electrical installation . . . . From experiments to test the efficiency of the plant, the following information was obtained: the loss in the engines is about 16 h. p.; in the shafting, about 0.45 h. p.; in belt and dynamo-friction, 3.4 h. p.; and in exciting the dynamo, 2.2 h. p. These losses, approximately constant for all loads, amount to about 22 h. p., and constitute the engine-room losses. The loss in the engine is large, on account of the

available steam pressure being low,—only 50 lbs. per sq. in."

A Dry Crusher and Pulverizer.

NOTWITHSTANDING the large number of good pulverizers and disintegrators on the market, a new candidate for favor appears under the name of The Niagara Dry Crusher and Pulverizer. It possesses many valuable features, such as readily accessible bearings, easily-regulated fineness of product, and compactness. It has proved a success in English cement manufacture, owing to the remarkable fineness of the product and comparative great capacity. Though better adapted to the less hard materials, it has been used on gold quartz. According to *The Colliery Guardian* (Oct. 4), "the largest size made at present is the 6-ft. machine, which will grind 20 cwt. of hard quartz per hour to pass a sieve forty meshes per linear inch with an expenditure of 11 h. p. The machine is run at a comparatively slow speed, not exceeding forty revolutions per minute, and the crushing surfaces do not come into immediate contact as they revolve. Both the grinding path in the drum and the ring of the roller are made of chilled iron, and can readily be replaced when worn. The drum, A, shown in diagram, is toothed externally and driven by a pinion, B, on a lay shaft, C. The crushing roller, E, which runs inside the drum on the path, D, is keyed on one end of a shaft, G, mounted on a swivel bearing at its outer end and running in a long intermediate bearing, which is pressed downwards by a powerful leaf spring, H. The drum itself is carried by four anti-friction rollers. Material is fed under the leading side of the roll, and, after crushing, is lifted by a number of scoops, I, fixed inside the drum on each side of the grinding path. These lift it and discharge it over the roller, which leads back any uncrushed material to be re-treated, whilst the fine material, as it falls, is at once removed by a blast of air produced by a suction fan.



DRY CRUSHER AND PULVERISER.

The air used circulates through the machine and pan over and over again, and, if necessary, it can be passed through settling chambers, where the finest dust can be deposited. By properly regulating the speed of the fan and the draught produced by it, crushed material of any desired size may at once be removed. When granulated or coarse products are desired, the roller is set up slightly. All the journals and bearings are placed externally to

the machines, so that they are readily accessible and can be protected from dust; but, as the air circulates continuously without any escape, there is but little dust to be seen about the machines, except that made by feeding at the hopper. The machine is self-contained and requires comparatively small foundations, running without much noise or vibration. When treating gold quartz, it is found that, by adjusting the speed of the air-current, a very good dry separation is produced, rich sand falling separately from the poor tailings. For tough substances the grinding surfaces are corrugated. The crushing in this machine, as is seen from the use of a fan, is done in the dry state, so that clay or wet material cannot readily be treated in it; but for thoroughly dry material the size of the product is remarkably uniform."

The Development of Iron and Steel Manufacture.

ADVANTAGE has been taken of the opportunity afforded by various international exhibitions in France to collect data relating to the condition of the iron and steel industry of the world. Mr. Shroedter, in a paper before the German Iron-masters' Association on "Iron and Steel Statistics," gives the following table of production in the exhibition years specified:

WORLD'S PRODUCTION OF PIG IRON.
(IN THOUSANDS OF TONS).

Country.	1867.	1878.	1889.	1893.
France.....	1,239	1,508	1,734	2,032
Belgium.....	423	519	832	760
England.....	4,839	6,366	8,458	6,930
Germany.....	1,264	2,148	4,524	4,953
America.....	1,326	2,338	7,872	7,239
Other countries..	934	1,419	2,609	4,875
Totals	10,013	14,298	26,027	26,989

In abstracting from the *Memoirs de la Société des Ingenieurs-Civils* (June), the *Iron and Steel Trades Journal* (Oct. 19) says that the improvements in steel manufacture are due to the "method of scientific and experimental research applied to the manufactures in France, where, he maintains, the progress made has been unquestionably greater than elsewhere, and where processes invented by foreigners have met with greater success. . . . During the first months of 1895 several manufacturers attempted the production of a steel possessing the following qualities:

Elastic limit... 56,893 to 64,004 lbs. pr. sq. in.
Ultimate tensile strength. ...113,786 " 184,902 " " " "
Elongation.....30 per cent.

"Although entire success has not been met with, some remarkable results were obtained as here shown:

	No 1. lbs. per sq. in.	No. 2. lbs per sq. in.	No. 3. lbs. per sq. in.	No. 4. lbs. per sq. in.
Limit of elasticity.	47,506	47,506	56,181	61,871
Resistance.....	95,011	98,709	107,811	126,586
	Per ct.	Per ct.	Per ct.	Per ct.
Elongation.....	46.0	47.5	49.8	35.6
Contraction.....	66.6	71.2	61.6	57.0

"The author thinks that chemical combinations exist which have not yet been revealed. Up to the present the attention of manufacturers has been confined to the mechanical properties and chemical composition of the metal; when it shall have been turned to the study of the molecular state, the author considers a great improvement in quality may be looked for, and maintains that this desideratum will undoubtedly be accelerated by the publication of the results of the experiments undertaken by the commission appointed in 1891 by the minister of works for France to experiment on materials of construction."

THE ENGINEERING INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Technical Journals—See Introductory.

Metallurgy

*1907. Determination of Chrome and Manganese in Steel. L. Schneider (A new method described in detail). Ir & St Tr. Jour-Sept. 28. 400 w.

1925. Pittsburg's Iron and Steel Industry as Seen by an Engineer (Present development at Pittsburg, especially of the Edgar Thomson Steel Works, and the Homestead Steel Works; also the situation at the National Tube Works, Duquesne Steel Works, the Westinghouse and other works of that region). Eng News-Oct. 10. 6700 w.

1931. The Ackerman method of Face-Hardening Armor (A method for increasing the thickness of the carbonized surface of a steel

We supply copies of these articles. See Introductory.

plate by producing folds or ridges on the surface before cementation, and then forging as usual). R R Gaz-Oct. 11. 1900 w.

†1939. The Estimation of Sulphur in Refined Copper. G. L. Heath (Read at the Springfield meeting. Calling attention to defects in methods already published, and presenting results of some experiments and an improved method, devised especially for the determination of traces of sulphur). Jour Am Chem Soc-Oct. 2300 w.

*1972. The Alleged Treacherousness of Ingot Iron (The report of the Committee of the International Conference on methods of testing structural materials, giving results of investigations at Zurich, and conclusions). Eng, Lond-Oct 4. 2000 w.

*1977. The Manufacture of Tool Steel in Styria and Lower Austria. From *Stahl und Eisen* (Description of the present practice at that locality in the crucible steel works). Ind & Ir-Oct. 4. 1200 w.

*1985. The Cost of Producing Iron and Steel in Belgium (Abstract from *The Revue Universelle* of calculations by M. J. Wolters, on Belgian girder manufacture). Ir & Coal Tr Rev-Oct. 4. 700 w.

2111. An Improved Ten-Ton Chlorination Barrel. John E. Rothwell (Description with detail drawings. A statement of its advantages over two five-ton barrels). Eng & Min Jour-Oct. 19. 600 w.

2122. Iron Manufacturing on the Congo (An interesting sketch of the progress of the industry among the natives). Am Mfr & Ir Wld-Oct. 18. 450 w.

*2138. The "Ropp" Straight Line Furnace. Ill. (Somewhat similar to the O'Hara type, or the Brown Horseshoe furnace straightened out; the stirrers return along the side of the furnace. It is said to have given very satisfactory results). Aust Min Stand-Sept. 7. 1800 w.

2160. Pittsburg's Lost Supremacy (An opinion of Mr. Andrew Carnegie respecting the effect of a Pittsburg Lake Erie canal, estimating a saving of $1.40 for each ton of steel manufactured, by help of such cheap canal transportation). Ir Tr Rev-Oct. 24. 800 w.

2174. Some Fuel Problems. Joseph D. Weeks (Address delivered at Atlanta before the A. I. M. E. A general view of fuels followed by remarks upon the mining use, and handling of coal waste, and upon coke manufacture). Am Mfr & Ir Wld-Oct. 25. 4000 w.

2181. Tin Plate Production (A report to the U. S. Treasury Department by Col Alger giving interesting statistics. There are 48 firms in the United States manufacturing tin plates, giving an increased production during the past fiscal year of 87½%). Ir Age-Oct. 24. 1000 w.

*2236. Recarburation of Steel in the Basic Converter by Means of Calcium Carbide (Quoting from an article in *The Iron Age* and giving some results communicated by a German Commission indicating that the process is impracticable). Ir & Coal Tr Rev-Oct. 18. 900 w.

2239. Tests of Tough Steel Castings. Ill. Gus C. Henning (Tests of coupons cast on a spider anchor plate for a suspension bridge, showing some excellent results. The castings are not allowed to cool in the sand but are transferred, while still red hot, to the annealing oven). Eng News-Oct. 24. 700 w.

2245. Recent Progress in Iron and Steel Manufacture (An interesting editorial pointing out the later improvements and showing the tendency to be toward "aggregations of capital in the shape of massive automatic machinery, and in the consolidation of all branches of the industry"). Eng News-Oct. 24. 1000 w.

2263. Occurrence of Tellurium in Oxidized Form Associated with Gold. Richard Pearce (A paper read before the Colorado Scientific Society, showing that with the South Dakota ore containing tellurium, the presence of pyrite affected the quantity of tellurium oxide upon roasting). Min Ind & Rev-Oct. 29. 1200 w.

2565. Metallurgical Works in New South Wales (Editorial. A new enterprise with £500,000 capital, proposing to treat the refractory Broken Hill ores by chemical means, employing the Storer-Marsh and Siemens-Halske processes). Aust Min Stand-Sept. 21. 1500 w.

2276. The Value of Practical Tests of Refractories. Charles Terry (An interesting series of observations to the effect that the qualities of fire brick can be known only by practical tests under working conditions). Ir Age-Oct. 31. 2200 w.

2277. The Slavianoff Electric Metal Casting System (The metal in the shape of a rod conducts a current direct from the dynamo, which is sufficient to melt the rod at the point of contact enabling one to cast one metal on another, mend castings or make new castings. Used by Julius Pintsch, Berlin). Ir Age-Oct. 31. 1500 w.

2298. The Iron and Steel Industries of the United States in the Census year 1890 (Abstracts from a report of the U. S. Commissioner of Labor, being Part III. of the final reports of the census of 1890, giving the number of iron and steel works at 719; the invested capital $414,044, 844; net tons product 18, 216, 215). Bul Ir & St Inst-Nov. 1. 800 w.

2299. The First Iron Enterprises at Pittsburg and in Allegheny County (An account of the early years of the Pittsburg iron industry. The first furnace was completed in 1792; the first foundry in 1803; the first steel furnace, 1810; the first rolling-mill in 1811 and 1812; the Clinton Furnace first used coke in 1859. The last furnaces put up are 100-ft. high and 22-ft. diameter at bosh). Bul Ir & St Inst-Nov. 1. 2000 w.

*2322. The Development of the Iron and Steel Manufacture as Shown by Recent Exhibitions in France (Read before the French Society of Civil Engineers, comparing the production of various countries and the improvements in the quality of steel). Ir & St Tr Jour Oct. 19. 700 w.

2338. Russia's Iron and Steel Industry. Charles Hyde (Paper read before the Eng. Soc. of W. Penna. giving interesting notes of a trip through the Russian iron works, showing the

industry more advanced than is generally supposed). Ir Tr Rev-Oct. 31. 3000 w.

2342. Plant for the Extraction of Gold by the Cyanide Process. Charles Butters and Edgar Smart (Abstract of paper in "Pro. of the British Inst. of Civ. Eng. Deals with the mechanical treatment principally and is well illustrated with drawing of South African plants). Eng & Min Jour-Nov. 2. 3500 w.

*2358. Nickel Steel and Armor Plates (A communication giving some of the most valuable properties of nickel steel, recommending it for boiler plates, and stating that it can be welded and will not readily corrode). Ind & Ir-Oct. 25. 1600 w.

Mining.

*1896. Side Lights on the South African Gold Boom. Albert Williams, Jr. (Comparing the "Kaffir" craze with the speculative fevers of the past, and outlining in a general way the ultimate results). Eng Mag-Dec. 3500 w.

1940. The Gold-Silver Veins of Ophir (Extract from a monograph by Waldemar Lindgren, published in the 14th Annual Report of the U. S. Geological Survey. The portion of the article relative to the gangue, and the altered wall rock). Min & Sci Pr-Oct. 5. 2400 w.

1949. The Lignite Industry of North Dakota (Brief description of these extensive deposits with methods of operating the mines). Am Mfr & Ir Wld-Oct. 11. 800 w.

*1950. The Persistence of Mines in Depth. (Editorial. Concluding that indications are usually so unreliable that no opinion but that of a scientific geologist should be relied upon). Min Jour-Oct. 5. 1800 w.

2022. The Effect of Washing With Water Upon the Silver Chloride in Roasted Ore. Willard S. Morse (Read at the Atlanta meeting of the Am. Inst. of Min. Eng. The results of experiments showing the action of zinc blende and other sulphides in affecting the quantity of chloride of silver in the roasted ore after washing, and the losses occasioned thereby in lixiviation). Min & Sci Pr-Oct. 12. 2000 w.

2034. Comparative Methods of Gold Mining and Metallurgy. W. M. Brewer (Methods of mining, ore treatment and barrel chlorination in the South, compared with other localities and criticised as being behind the times). Tradesman-Oct. 15. 1800 w.

2037. The Magnetization and Concentration of Iron Ore. William B. Phillips (Read at the meeting of the Am. Inst. of Min. Eng. at Atlanta. The results of experiments at Bessemer, Ala., in concentrating a low grade hematite, rendering it magnetic by heating in a Davis-Colby kiln, and treating in a Hoffman separator. One ton of 55 per cent. ore was produced for $1.15). Ir Age-Oct. 17. 4500 w.

*2058. Coal Mining in the Province of Hanover (A review of the condition of the industry as brought out by the Mining Congress held at Hanover in September. The large quantity of coal converted into briquettes is a notable feature). Col Guard-Oct. 4. 1600 w.

*2060. The Niagara Dry Crusher and Pulverizer. Ill. (Description, with sectional illustration of one of the most successful fine crushers in use). Col Guard-Oct. 4. 600 w.

*2079 Hydraulic Pumping Plant at the Cefu Colliery Near Bridgend James Barrow (A paper read before the South Wales Inst. of Eng., describing with sketches nine pumps consisting of an ordinary pump at the surface which transmits its water under pressure, to the mine pump 820 yards below where it acts as the moving power). Col Guard-Oct. 11. 1500 w.

2120. Mining in Siam (A report made by the Siamese Consul General on the occurrence of various minerals, and the tin exported in 1893-94 with an outline of the conditions under which licenses and mining leases are granted). Min Ind & Rev-Oct. 17. 1700 w.

2123. The German Brown Coal Industry. Dr. Max Fiebelkorn (Translated from *Chemische Industrie*. A description of the Rolle Coking system and the utilization of by-products in coking of lignite). Am Mfr & Ir Wld-Oct. 18. 1300 w.

2125. No More Oil Well Shooting (Method consists of pumping water and acid to the bottom of the oil well where it dissolves the cementing medium of the rock, making it more open and thus letting the oil flow more freely). Am Mfr & Ir Wld-Oct. 18. 900 w.

*2126. The Amalgamation of Free Milling Gold Ores (Editorial criticism of an article, "The Mining Industry," which makes "mechanics subordinate to metallurgy." The editor argues that we must look to mechanical appliances for further development in amalgamation). Min Jour-Oct. 12. 1100 w.

2132. The Kaffir Craze (A very interesting account of the South African mines speculation, including a description of the deposits of gold ore and the extent to which inflation and speculation has gone). Bradstreet's-Oct. 19. 2300 w.

*2140. The Niagara Crusher and Pulverizer. Ill. (Consists of a heavy fixed edegrunner inside a revolving cylinder, crushing the material between them. Pockets at the sides of the roller and inside the barrel, drop the crushed material, which is sucked out by a fan while falling. It has done good work and is readily adjusted and repaired). Ir & Steel Tr Jour-Oct. 12. 1500 w.

2146. "The Coming Crash." Almarin B. Paul (Discussion of the South African gold mines speculations, holding that there is considerable backing in the natural resources of Africa to warrant the enormous amount of money sunk in these properties). Min & Sci Pr-Oct. 19. 1600 w.

*2210. Firedamp Imprisoned in the Coal of the Saint Etienne Mine, With the Means Taken for Ascertaining its Pressure. M. P. Petit (A communication to the Société de l'Industrie Minérale concluding that outbursts of gas are more liable to take place when the coal is compact, and that the distribution of regions of high gas tension is so variable that bore holes give no efficient relief. A good article giving results of experience in French collieries). Col Guard-Oct. 18. 5000 w.

We supply copies of these articles. See introductory.

*2211. Electric Light and Power in Mines. Sydney F. Walker (Description of different apparatus used for the generation and transmission of power in mines, the principles involved, and causes of failure). Col Guard-Oct. 18. Serial. 1st part. 2000 w.

*2213. The Kootenay Mines, British Columbia (A sketch of the geography of the locality, history, and descriptions of some of the principal mines). Min Jour-Oct. 19. Serial. 1st part. 4300 w.

2221. Is an American Mining Boom in Sight? (Giving examples of English capital coming to the United States and a comparison between Johannesburg production and profits and those of Cripple Creek as given by the *Denver Republican*. Concludes that prospects for future developments look bright). Bradstreet's-Oct. 26. 1500 w.

*2231. The Progress of the Cyanide Process (The use of the cyanide process on low grade gold ores, prospects of roll crushing in place of stamps, and description of some new plants and improvements). Mach-Oct. 15. 2500 w.

*2235. Welsh Anthracite Coal. Mr. Howard (Paper read before the Pacific Coal Gas Asso. Discussion of the bearing of Welsh coal on California industries, its competition with Vancouver bituminous coal and native petroleum, and the question of available fuels in general). Ir & Coal Tr Rev-Oct. 18. 2800 w.

2262. Placers and Gold Mines. A. L. (The condition of the gold placers in British Columbia). Min Ind & Rev-Oct. 24. 900 w.

*2264. Hydraulic Sluicing in New Zealand (An alluvial deposit comprising a mass of cemented breccia which was blasted in faces sometimes 100-ft. in height and sluiced, but now worked by improved methods which are described). Aust Min Stand-Sept. 14. Serial. 1st part. 1600 w.

2266. The Mechanical Separation of Lead, Zinc Sulphides. F. Hille (A comparison between American and German machines and methods with official figures from the Himmelfohrt mine, Saxony, on the results of concentration; also reference to the work of the British Columbia Mines). Can Min Rev-Oct. 1500 w.

2267. How Gold Occurs in Nature. W. Nichols (Digest of an elementary lecture delivered at Field's Columbian Museum, Chicago). Can Min Rev-Oct. 1800 w.

2268. Metal Mining. J. H. Collins (Extracts from a presidential address before the Institute of Mining and Metallurgy, London, on special features in mining, such as climate, scale of operations, pilfering, transit facilities, rates of interest, etc.). Can Min Rev-Oct. 1100 w.

2269. Electrical Haulage at Earnock Colliery. Robert Robertson (The saving effected by substituting electricity for horses). Can Min Rev-Oct. 300 w.

2279. The Anaconda Sale (Discussion of the reported sale of a ¼ interest in the Anaconda Mining Co.—whose property is valued at $30,000,000,—to English capitalists. These mines hold the world's record of production, having made as high as 13,000,000 pounds of copper per month). Ir Age-Oct. 31. 500 w.

2286. Steel Frame Stamp Battery. Ill. (A type of double five stamp battery, built in England for South Africa. It is made almost entirely of iron and steel, with 850-lb. stamps and chrome steel shoes). Min & Sci Pr-Oct. 26. 600 w.

2287. The Sampling and Measurement of Ore Bodies in mine examinations. Edmund B. Kirby (A series of papers on the valuation of discovered ore, written in a comprehensive style). Min & Sci Pr-Oct. 26. Serial. 1st part. 900 w.

*2323. Humidity and Temperature Observations at the Maybach Colliery, near Saarbrucken. H. Fischer (Description of water spraying arrangement used in the hot, dry, deep workings to prevent the accumulation of coal-dust, which would produce serious disaster when ignited. Condensation in the upcast shaft amounts to as much as 8½ % of the total influx. The inside temperature was as high as 90° Fahr.). Col Guard-Oct. 25. 1500 w.

*2324. The Bernissart Collieries, Belgium (Description of a coal mine dating from 1830 and which possesses excellent communication facilities). Col Guard-Oct. 25. 1500 w.

*2359. Physiography and Geology of the Wadnaminga Gold Fields, South Australia. F. D. Johnson (A paper read before the Australian Inst. of Min. Eng. The ore bearing formations are described in detail). Min Jour-Oct. 26. Serial. 1st part. 3300 w.

†2373. What is Bitumen? S. F. Peckham (An investigation into the proper classification of bitumens, showing the distinction between terms commonly used). Jour Fr Inst-Nov. 4200 w.

2403. Big Mountains for Big Mines. Dan De Quille (A rule for prospectors indicating that the richest ores of the precious metals usually lie along the largest ranges, giving also some opinions as to conditions favorable for the presence of ore). Min Ind & Rev-Oct. 31. 2300 w.

*2447. The Swedish Iron Ore Industry (A description of the various deposits showing the surface magnitite to be higher in phosphorus, while the lower lying specular ores contain less. Most of the exported magnetites go to Germany). Ir & St Tr Jour-Oct. 26. 500 w.

*2460. Electricity in Bituminous Coal Mining. Ill. R. M. Haseltine (A rather long drawn out article describing the results of tests with electric mining machines in Ohio coal mines). Col Eng-Nov. 8400 w.

*2461. An Automatic Switch. Ill. (A switch designed for track running from a two compartment shaft, which is set by the cars running over it. It has been giving satisfaction in Pennsylvania coal collieries for a number of years). Col Eng-Nov. 600 w.

*2462. A Gravity Automatic Switch. Ill. J. J. Ormsbee (This device, which is in use at a Pennsylvania colliery in which a loaded car throws the switch rails down an incline laterally to its track, while the empty car has not sufficient weight to raise the counter weight and so goes straight ahead). Col Eng-Nov. 300 w.

*2463. The Capell Fan. Ill. (A cylinder fan having a vane device at entrance which acts like a screw-propeller, and short curved vanes along the periphery. The one described is 8 ft. diameter, 7 ft. long, with two inlets; at 208 revolutions it delivered 108,000 cu. ft. of air per minute). Col Eng–Nov. 1000 w.

Miscellany.

1948. The Manufacture of Coal Briquettes. William Colquhoun (Abstract of a paper read before the Brit. Inst. of Civ. Eng. with illustrations of the various machines used and a description of the method of operating). Eng & Min Jour–Oct. 12. 3000 w.

*2078. The Geological Survey of Scotland and Ireland (From a report by Archibald Geikie, Director of the Survey, giving results of later investigations). Col Guard–Oct. 11. 4000 w.

*2080. Coal Mining in South Africa (Report on the coal deposits of Matabeleland and 140 miles northwest of Buluwayo. These coals contain 60 to 70% of carbon). Col Guard–Oct. 11. 700 w.

*2081. Report on the Quarter Colliery Explosion (Account of firedamp explosions in a Stirlingshire colliery with the evidence relating to the cause). Col Guard–Oct. 11. 2200 w.

*2121. The Mining Schools of Germany (A general review of advantages and course of study at Clausthol, abstracted from a U. S. Consular Report). Jour Soc of Arts–Oct. 11. 1100 w.

2124. Galvanic Zincing of Iron (Abstract from a work by Carl Richter, Leipzig, giving full details of the modus operandi, with necessary precautions). Am Mfr & Ir Wld–Oct. 18. 1600 w.

*2208. Output of British Minerals (Abstract from the official report on the mineral production of Great Britain with statements of imports and exports). Chem Tr Jour–Oct. 19. 1400 w.

*2209. Diving-Exercise Shaft of the Westphalian Miners' Association. H. W. Bracht (A shaft for the use of students when practicing the putting together of pipes, erecting pumps, etc., under water. Some students are unable to work at a depth greater than 11 fathoms, though the greatest practicable depth is 17½ fathoms). Col Guard–Oct. 18. 1100 w.

*2214. The Training of a Mining Engineer (An inaugural address by Henry Louis, Professor of Mining, before Durham College of Science). Min Jour–Oct. 19. Serial. 1st part. 2300 w.

*2215. The Gold Mines of the Rand (Editorial comment upon a new book published by Macmillan & Co., and reference to the opinions of Messrs. Smith and Hammond, experts, and to an article in the *Nineteenth Century*, treating principally of deep level mining, and showing that the deposits are immense). Min Jour–Oct. 19. 3200 w.

2278. The Mining Building at the Atlanta Fair (Description of the building and the principal mining exhibits at the Atlanta Exposition). Ir Age–Oct. 31. 1500 w.

2280. Analytical Methods at Duquesne. J. M. Camp (From a paper read before the Eng. Soc. of W. Penna., on methods in use in the Pittsburg region in the chemical determination of iron, manganese, and phosphorus contained in iron and iron ores, and also nickel in steel). Ir Age–Oct. 31. 2400 w.

2302. An Ore Testing Plant. H. C. Cutler (Description of the Mining and Metallurgical Equipment of the University of Minnesota having a capacity for heating ore in lots from 500 lbs. to one car load. The equipment cost $6000 and is said to be full size). Sci Am Sup–Nov. 2. 800 w.

†2311. On the Analysis of Alloys of Lead, Tin, Antimony and Arsenic. Launcelot Andrews (Description of two quick methods giving close results). Jour Am Chem Soc–Nov. 900 w.

†2312. The Determination of Graphite in Pig-Iron. P. W. Shimer (The sources of error due to solution in H. Cl. an account of the presence of titanium and other carbides which would be dissolved in nitric acid solutions). Jour Am Chem Soc–Nov. 900 w.

†2313. On the Volumetric Determination of Titanic Acid and Iron in Ores. H. L. Wells and W. L. Mitchell (Describing the advantages of solution in sulphuric acid and the accuracy of the volumetric method). Jour Am Chem Soc–Nov. 1600 w.

†2314. The Evolution Method for the Determination of Sulphur in White Cast-Iron. Francis C. Phillips (Based on the assumption that the contained sulphur unites with the escaping hydrogen, forming hydrogen sulphide. Giving the results of various experiments). Jour Am Chem Soc–Nov. 3000 w.

†2315. On the Volumetric Determination of Lead. Allerton S. Cushman and J. Hayes Campbell (A description of the modified Schwartz method in which lead is precipitated as a chromate). Jour Am Chem Soc–Nov. 1000 w.

†2371. Aluminum Solders. Joseph Richards (Short history with analyses made in the development of a satisfactory solder. The solder as now made contains aluminum, zinc, tin, and phosphorus). Jour Fr Inst–Nov. 1000 w.

†2374. On the Technical Analysis of Asphalts. Samuel P. Sadtler (An improved method for the determination of "petrolene" and "asphaltene" in asphalts, using acetone to extract the former and chloroform to extract the latter). Jour Fr Inst–Nov. 900 w.

2404. Geology of Cripple Creek.—Report of the United States Geological Survey.—Mining Geology. R. A. F. Penrose, Jr. (The region is dictinctly gold bearing and the article describes the manner of occurrence of gold as being principally in dykes and fissures in granites and in eruptive rocks). Min Ind & Rev–Oct. 31. 2500 w.

2448. West of Scotland Iron and Steel Institute (Condensed address by the president on technical education, contrasting the excellent scientific schools of Germany and the United States, with the less efficient ones of England, and giving this as a cause for the superior development of practical metallurgy in the former countries). Ir & St Tr Jour–Oct. 26. 800 w.

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Vitrified Paving Brick.

THE term "vitrify" is defined by Webster as meaning to "convert into glass by fusion, or the action of heat." "Vitrified," therefore, according to this definition, means converted into glass by fusion, or the action of heat. The "Standard Dictionary," recently issued, defines "vitrified" as "converted wholly or *externally* into glass or a glassy substance, . . . as vitrified brick, vitrified pottery, etc." The "Century Dictionary" says that *vitrified* means "converted into glass, hence, by extension, *partially converted* into glass," etc. The last two definitions are seen to include the technical meaning of the word as applied to incipient vitrification in many materials, as, notably, paving brick, which, if completely vitrified or wholly converted into glass, are, according to Professor H. A. Wheeler, in his new treatise,* inferior to those vitrified to a stage of incipient vitrification. But what he says upon this topic in his excellent little book is so interesting and instructive that we prefer to quote it *verbatim*.

"There is a misconception among some engineers and brick-makers as to the definition of vitrified brick, as, unless a brick shows a decidedly glass-like fracture, they refuse to call it vitrified, and even condemn brick, from the lack of such glassiness, that are not infrequently the toughest and most durable of pavers (brick with a stone-like fracture). They quote Webster to substantiate their claims, thereby failing to discriminate between a popular definition and a technical or special use of the term. The No. 1 pavers that are at present on the market, whether made from impure fire clay or shale, are nearly always vitrified, though much more thoroughly vitrified in the latter case.

"To properly appreciate the correct use of the technical term, vitrified brick, it is desirable to look at the change that occurs in paving clays in passing from the condition of a mud to a distinctly glassy mass. A plastic clay, when mixed with a proper amount of water, makes a mud or paste that can be readily molded, and yet is tenacious enough to retain the shape given to it in molding, if carefully handled. On drying off the mechanically-admixed water that rendered it plastic, it shrinks 2 to 11 per cent. to a firm earthy mass that bears handling, though it is so soft as to be easily scratched by the finger-nail, and the individual particles of clay are easily distinguished. On heating the dry clay to a red heat for about 1200 deg. (F.), the chemically-combined water is driven off, which renders the clay non-plastic, and it again begins to shrink and to grow harder and stronger as the heat is raised above redness; but the individual particles of clay are still easily recognized, and the clay is very porous. When the heat is further raised to about a bright cherry heat (or from 1500 to 1800 deg. F.), depending on the particular clay, it shrinks an additional 1 to 10 per cent.; it is very much stronger, much less porous, has acquired the hardness of tempered steel, and the individual particles are no longer recognizable. This point, which is quite well defined, I have called the point of incipient vitrification; from thence to the stage of a molten mass there is no longer any sharp line of demarcation, as it imperceptibly becomes more and more vitreous, and gradually begins to soften and change its shape, especially under pressure. It finally becomes a very viscous semi-liquid, and, when chilled and broken, presents a thoroughly glassy appearance.

"From the point at which the clay particles have sufficiently coalesced that they can be no longer recognized, or the point of incipient vitrification, to the point of viscous liquidity, requires an increase in

* Vitrified Paving Brick. A Review of Present Practice in the Manufacture and Use of Vitrified Paving Brick. By H. A Wheeler, E. M., clay specialist of the Missouri geological survey. Indianapolis, Ind.: T. A. Randall & Co., 1895.

temperature of 100 to 600 deg. F., depending on the kind of clay, and is usually 400 deg. in the clays suitable for paving brick. Midway between these two points the clay ceases to be porous and stops shrinking; it has attained its maximum hardness, or scratches quartz; it has a maximum toughness and cross-breaking strength, if slowly cooled, and the fracture shows complete coalescence of the particles, or it is completely vitrified, though the shape is retained if not subject to pressure. This stage, though not sharply defined, I have called the point of complete vitrification; though difficult to describe, it is quickly and easily recognized by the trained eye. It is the stage that clay should be brought to in order to make an ideal paving brick. If heated higher, there is a slight loss in hardness, a much greater risk of brittleness, and a marked tendency to be distorted from incipient flow, though the fracture is more decidedly glassy; yet this advanced stage is what some think a brick should be brought to in order to be called vitrified from Webster's point of view.

"Salmon brick, having been exposed to only a red heat, are extremely porous, and they absorb from 15 to 30 per cent. of water; they are very soft, or from 2.5 to 3.0 in hardness, and are in the initial stage of shrinking, hardening, and strengthening.

"Hard building brick, having been raised to a cherry red heat, are less porous, and absorb from 6 to 15 per cent. of water; they are much harder, or from 4.5 to 5.5 hardness, are much stronger, and, while showing considerable shrinking, the distinct grains of the clay are still evident.

"Fire-clay paving brick usually exhibit a homogeneous, compact, dense body, in which the grains of clay can no longer be discerned, and have reached the stage of incipient vitrification; they are slightly porous, or absorb from 3 to 6 per cent. of moisture; they are very hard, being able to scratch glass or steel, or are 6.0 to 6.5 in hardness, and are very tough and strong. They are sufficiently dense and strong to successfully withstand frost, and are hard and tough enough to wear well under moderate traffic.

"Hard-burned shale brick usually exhibit a very dense, thoroughly homogeneous, compact body that shows complete vitrification; they are practically non-porous, or absorb from 0 to 2 per cent. of moisture; they are extremely hard,—being able to scratch quartz,—they are very strong and tough, and pre-eminently adapted for street paving, if slowly cooled.

"The salmon and building brick are too soft, too porous, and too weak for street-paving purposes. Fire clay paving brick and hard-burned shale brick are both suitable for pavers, and both are vitrified, but the important distinction should be made that one is only incipiently or slightly vitrified, while the other is completely or thoroughly vitrified."

Large Purification Boxes without Water Lutes.

THE water lutes of purification boxes occupy so much space that, where space in gas works is limited, it is desirable to avoid their use. To this end Mr. H. E. Jones, as is stated by *The Gas World* (Oct. 12), erected some purifiers at the Wapping (Eng.) gas-works some 10 years ago, in which a Z-shaped flange and a gasket were made to replace the water lute. Similar purifiers have since been erected at Margate and Eastbourne.

Some enormous purifiers without water lutes have recently been erected by Mr. H. Green at Preston, Eng., of which the following is a description: This set of purifiers is noteworthy, not only because of the absence of water lutes, but also for size. "Some time ago Mr. Green had to face the problem of how to extend his purifying power in a limited space—a problem which falls to the lot of most engineers in the course of their professional career. In this particular instance Mr. Green has solved the problem in a decidedly original way." The boxes measure about 95 ft. by 35 ft. At intervals there are thrown across the box iron plates or girders 2 ft. broad, and between these there are covers of lids about 10 ft. square, fixed down gas tight with a dry jointing material, and lying almost flush with the cross plates. Consequently,

when the covers are in position, the whole surface of 95 ft. by 35 ft. is almost flat, and, when the covers are removed, the whole makes one open-topped box, with the exception of the 2-ft. cross plates. The box is supported on girders, with a cellar beneath, for the reception of the waste purifying material. Beneath some of the lids, in the bottom of the box, there are shoots closed by plugs. Then the cover is raised, the plug is drawn out from the top, and the material on the adjacent sieves is shoveled to and down the shoot into the cellar. By adopting this system Mr. Green has saved about 30 per cent. in iron, and also a considerable amount of space. The covers, being small in size, and without the deep flanges required with the water lute, are comparatively light, and can therefore be raised with great ease and speed, the saving of labor in this respect being very considerable. The facility with which the saturated material can be discharged through the shoots also results in a reduction of the labor bill. In the charging of the boxes the cross plates serve as gangways for the men engaged in the work. Each box contains about 150 tons of material, and they have been running for over 18 months without charge.

"It would appear that huge boxes have given every satisfaction at Preston; but whether they can be recommended under all circumstances is doubtful. For one thing, with boxes of this enormous size it is apparent that a large part of the purifying plant must be put out of action when a change of material has to be made; and in many cases this may be against the system. It is also doubtful whether the sequence of chemical reactions that are necessary to compliance with the 'sulphur clauses' can be obtained so easily on this large scale as with boxes of less magnitude. Still, the experiment that Mr. Green is making merits the attention of the profession, and especially of those whose make is getting beyond the capabilities of the ground at their disposal."

A 60-In. Steel Conduit.

A FINE example of trench and conduit work is in progress at Allegheny, Pa. This steel conduit is to be 60 in. in diameter and 10 miles long, and will convey water to the city from an intake at Montrose on the Allegheny river. *Engineering News* (Oct. 10) prints an elaborate illustrated description of this important engineering work, from the pen of a member of its staff who visited it. The conduit was designed by Mr. Robert Swan, supervising engineer, and, when completed, will supply 50,000,000 gals. per day to the city.

"The contract for the pipe line was let to T. A. & R. G. Gillespie, of Pittsburg, Pa., at $850,000, this contract including the pipe, valves, specials, and pipe-laying complete. The pumping station is being built by the Jutte & Foley Co., of Pittsburg, and will be equipped with three compound, condensing, high-duty pumping engines, each of 12,000,000 gals. daily capacity, for which the Groshon High-Duty Pumping Engine Co., of New York city, has the contract. The foundations for the pumping station are in very soft and treacherous material, and the walls have been carried down 55 ft. to a thickness of 24 ft. at the base. The trench for the pipe line is largely in a sandy gravel, but also passes through rock and various material. The backfilling was originally specified to be done with moist earth in layers 6 in. deep, each thoroughly tamped, pounded, and rammed. In practice the backfilling is tamped underneath and over the pipe, and then from the top of the pipe to the surface the trench is filled by the 'Little Giant' road steam shovel," described and illustrated in our department of "Improved Machinery and Appliances" for November, and built by the Vulcan Iron Works of Toledo, Ohio.

The pipe is of soft open-hearth steel, having a tensile strength of from 55,000 to 65,000 lbs. per sq. in.; elastic limit, 32,000 lbs.; elongation, 25 per cent. longitudinally in the direction of rolling, and 22 per cent. transversely; reduction of area, 50 per cent. . . . The steel is specified not to contain more than 0.05 per cent. of either sulphur, phosphorus, or silica, and 0.05 per cent of manganese. The carbon is not specified, and it is limited by the physical requirements.

"The plates must allow cold scarfing to a fine edge without signs of fracture. Shop rivets are open-hearth soft-steel, of the same chemical composition as the plates."

"The pipe is made up in the shop in lengths of four courses, inside and outside course alternating, the longitudinal seams not less than 12 or more than 30 in. apart. In the trench the pipe line is laid so that the longitudinal seams of all inside courses (except curves and angles) are in line and have the calking edges facing upward. For angles and curves the outside courses must be punched so as to form the proper angles, or as many circular seams as may be required, no angle greater than 2½ deg. being made at any one circular seam. The outside courses may have their seams at either side on the upper half of the pipe, but must have the calking edges facing upward. These special or curve pipes may be made no less than four sheets and in sheets less than 6 ft. wide, if deemed necessary. Reducers and taper courses must have the plates so cut and punched that the pitch lines of the rivets in the circular seams are parallel to each other and perpendicular to the axis of the pipe.

"The edges of all plates are planed to the proper lines, and beveled for calking all around, no beveling by shearing being allowed. The pipe is calked at all seams and joints, inside and outside, before any protection coating is applied. At the laps the thickness of the plates is reduced to a fine edge by hammering, and this thin portion has two long rivets. All field and shop calking is what is known as Connery's concave calking, no split calking being allowed."

It will take 3500 tons of ½-in. steel plates to construct this pipe. The edges of the plates are planed to a bevel of 63° with the flat sides, and, after riveting, the edges are caulked as in boiler work. After this the pipes are japaned by the Sabine process.

Injury to Pipes by Electrolytic Action.

THE following is a summary of the results of investigation made by Messrs. Stone and Webster, consulting experts, and printed in the annual report of Mr. Wm. Jackson, the city engineer of Boston. "In certain places throughout the city electrolytic action is taking place; pipes have already been more or less injured, and are subject to premature decay. Excavations which have been made about the city for the purpose of inspecting the pipes have given only negative results, revealing no marked action, and yet not proving that the natural decay has not been accelerated by electrolysis. Action of a serious nature is confined to special localities, where, owing to certain conditions of the railway system, abnormal currents are flowing through the earth; but as a whole, the action has been reduced to so small an amount that it is now difficult to detect. In the places where action is found, special precautions in provision of return feeders, and connections with the piping system by the street railway company, will ordinarily reduce the difficulty to a small amount. It is impracticable to entirely eliminate electrolytic action, but, by a constant inspection of the water system as a whole, with a view of locating points where difficulty is liable to occur, and applying such remedies as are well known, the danger can be reduced to a minimum.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Municipal Engineering in the American, English and British Colonial Technical Journals—See Introductory.

Gas Supply.

*1917. The Dvorkovitz Oil Gas Enrichment Process at Bradford (Mr. Wright's first report; Mr. Wood's report on the working from Feb. 4 to March 9, 1895; Mr. Dvorkovitz reply to Mr. Wood's report; Mr. Shaw's letter to the "Bradford Observer"; Messrs. Newbigging and Son's report to Mr. Smith; reply by Mr. Cowgill; Mr. Wright's replies to Mr. Wood and Messrs. Newbigging). Jour Gas Lgt-Oct. 1. 9000 w.

*2009. The Bradford Oil-Gas Controversy (A continuation of the history of this dispute, consisting of letters from Messrs. Newbigging, Mr. Wright and Messrs. Wood). Gas Wld-Oct. 5. 9000 w.

2029. Acetylene at Work. Ill. (An account of the preparations for business of the Acetylene Light, Heat, and Power Co. of Philadelphia, with notes on the use and advantages of acetylene). Pro Age-Oct. 15. 1200 w.

We supply copies of these articles. See introductory.

2030. The Gas Ice-Factory at Newport, R. I. Ill. (The object of the article is to convey a clear idea of the ice-factory in question and of its relation to the gas-industry in general. It first explains of what the manufacture of ice consists). Pro Age-Oct. 15. 2900 w.

*2042. On the Encouragement of the Small Consumer. J. Holliday, with discussion by members (The ground is taken that small consumers will always form the most important part of the patronage of gas companies, and that class of consumers can be materially increased by a liberal policy. The coin meters have already effected this to a noticeable extent). Jour Gas Lgt-Oct. 8. 6000 w.

*2101. Purification at Preston (Describes a set of purifiers of extraordinary size and without water lutes. The experiment m rits the attention of gas engineers who suffer for want of room). Gas Wld-Oct. 12. 800 w.

*2105. Blackburn Corporation Gas Works (Deals with results and does not enter upon details of plant). Gas Eng's Mag-Oct. 10. 1100 w.

*2106. Standardizing of Meter Unions. F. Napier Myers (Read before the N. Brit. Asso. of Gas Managers. Points out the advantages that would arise from the adoption of such a standard and advocates a combined effort to secure it). Gas Eng's Mag-Oct. 10. 1200 w.

*2136. Questions Concerning Prepayment Meters (Review of a discussion which followed the reading of a paper on the subject before the North of England Gas Manufacturers' Association). Jour Gas Lgt-Oct. 15. 900 w.

2232. The Creation of a Healthy Public Sentiment toward the Gas Company in the Locality in which it Operates. W. H. Rogers (Read before the 23d annual meeting of the Am. Gas Lgt. Asso. How to treat customers. The policy to adopt in dealing with complaints, etc. Discussion). Am Gas Lgt Jour-Oct. 28. 5000 w.

2233. Retort House Design and Practice. A. E. Forstall (How to design, build and run a retort house. An eminently practical paper, read before the Am. Gas Lgt. Asso., with an appendix giving list of tools necessary for best practice and discussion). Am Gas Lgt Jour-Oct. 28. 7000 w.

2234. Obtaining Cyanogen or its Compounds from the Gases Resulting from the Dry Distillation of Substances of Organic Origin (Complete description of a process invented by H. Dreshchmidt, of Berlin, and patented in England). Am Gas Lgt Jour Oct. 28. 2200 w.

2367. Laying a Submerged Gas Main (Illustrated detailed description of the submerged main across the Harlem ship canal at Kings Bridge, New York City. Depth of submergence, about 20 ft.) Eng Rec-Nov. 2. 1300 w.

Sewerage.

*2031. Construction of a Sewage Irrigation Plant (The application of sewage to land recommended, and plant described). Dom Engng-Oct. 900 w.

†2187. The Ventilation of Sewers. W. F. Van Buskirk (An argument in support of the theory that disease germs may be transported by sewer air. Short discussion). Eng Soc of School of Prac Sci-No. 8. 1400 w.

†2193. Sewage Disposal in Ontario. R. W. Thomson (A discussion of the feasibility and desirability of adopting the system of filtration and application of the filtered sewage to land, for the sewage of Ontario. Results of the system in other cities reviewed). Eng Soc of School of Prac Sci-No. 8. 2500 w.

2240. Present European Practice in Regard to Sewage Disposal. Allen Hazen (Paper read before the Boston Soc. of Civ. Eng. A general review of the subject including a statement of the problems in sewage purification, and the methods by which these have been met, and wholly or partially solved by engineers in different cities). Eng News-Oct. 24. 4500 w.

†2433. Sewage and Garbage Disposal at Manchester, England. From consular report to State Department. William F. Grinnell, Consul (The sewers of the city are diverted to the outfall works, 5 miles below the city. The cardinal object was to avoid pumping, if possible, and this has been accomplished, the whole drainage finding its way by gravity. The dry refuse is used on the "Carrington moss estate" with great success). San-Nov. 2400 w.

Streets and Pavements

*2346. Requirements in the Manufacture of Paving Brick and Sewer Pipe. Heinrich Ries (Condensed from an article on "Technology of the Clay Industry" to appear in the annual report of the United States Geological Survey. Discusses mixtures of clays which give best results, temperature at which vitrification begins, preparation of clay for mixing pug-mills, stiff mud machines, drying floors, sewer-pipe floors, chamber dryers, progressive dryers, absorptive power of paving bricks, crushing strength, glazing of sewer pipes, &c). Pav & Mun Eng-Nov. 6000 w.

*2347. Production and Importation of Asphalt. E. W. Parker (Condensed from special advance sheets of the annual report on mineral resources by the United States Geological Survey). Pav & Mun Eng-Nov. 350 w.

2416. How to make a Good Paving Brick. M. F. Ellis (Treating of paving brick, its qualities of clays and the best mode of its manufacture). Brick-Nov. 1800 w.

Water Supply.

*1887. Investigation of Public Water Supplies. Floyd Davis (A sanitary classification of potable waters and of the tests thereof, and a statement of the purposes of these tests). Eng Mag-Dec. 3600 w.

1921. Sixty-Inch Steel Conduit for the Water-Works of Allegheny, Pa. Ill. (Description of a very important and extensive piece of trench and conduit work in which the excavation and most of the backfilling is done by the "Little Giant" steam shovel, manufactured by the Vulcan Iron Works, of Toledo, O. The pipe is of steel riveted and in laying is subjected in places to both vertical and horizontal curvature). Eng News-Oct. 10. 2800 w.

†1933. Filters. From *The Practitioner* (A consideration of the precautions necessary to make filtration not only capable of straining and chemical purification, but capable of arresting disease germs). Sanitarian–Oct. 2000 w.

*1947. Metropolitan Water Supply (A consideration of the supply for London, and its need of enlargement. The sources of supply to which attention is directed). Arch. Lond–Oct. 4. 2200 w.

1960. Water Consumption in Chicago. Fred De Land (Daily consumption 149 gallons per capita. Unnecessary waste and leakage considered. Comparison with other cities in this and foreign countries. The waste a matter of individual responsibility). Elec Engng–Oct. 1800 w.

1999. Cincinnati's Water Department (Ill. (Extracts from report of Supt. Willis T. Thorp, with illustrations of some of the costly towers and buildings erected for the use of the department). Fire & Water–Oct. 12. 500 w.

2010. The Use of Sea Water for Municipal Purposes. Francis J. Allen (Recommending the use of sea water for flushing drains, sewers, &c., where there is an insufficient supply of water. The objections stated and proved groundless and the subject thoroughly discussed). Plumb & Dec–Oct. 1. 2800 w.

2092. Sand Washing at the Hamburg Filter Works (Illustrated description of process and plant). Eng Rec–Oct. 19. 1100 w.

2094. Filtration and Leakage Through Large Reservoirs. Ill. (Abstract from a paper read in Paris, on "Precautions to Take in the Construction of Great Reservoirs for Water," by M. Dutoit. Describes methods adopted in the construction of the most recent Paris reservoir, to prevent damage to foundations, &c., by infiltrations, and methods in use in that city to maintain efficiency of reservoirs notwithstanding cracks). Eng Rec–Oct. 19 1200 w.

*2108. The Relative Value of Percolation Gauges. R. E. Middleton (Abstract of paper read before the Soc. of Eng., England. An investigation of the reliability of percolators in which four different ones were critically examined. Records are very contradictory). Ind & Ir–Oct. 11. Serial. 1st part. 3000 w.

*2170. London Water (Editorial review of the report of the chief engineer of the London County Council, with map showing available sources of supply). Engng–Oct. 18. 2500 w.

2223. Inclosed Standpipe, St. Charles, Mo. (Abstract of a paper read June 5, by Edward Flood before the Engineer's Club of St. Louis, Mo. Besides describing and illustrating details of construction of the stand-pipe named, the paper deals with the general subject of standpipe construction, and causes of failure to be guarded against). Fire & Water–Oct. 26. 1500 w.

*2325. Metropolitan Water Supply (A critique of the scheme of the water committee of the county council of London, which proposes to supply London with water from the highlands in the south of Wales). Engng–Oct. 25. 3300 w.

2405.—75 cts. Electrolysis. H. A. Storrs (Paper read before the New England Water Works Association, Sept. 11, 1095. Practical information gleaned from technical publications and arranged under three different heads. (*a*) Remedies in case of cities where electric roads are already in operation. (*b*) Preventive measures for cities where roads are yet to be installed. (*c*) Some of the legal aspects of the subject. Discussion by members). Jour of N Eng Water Works Asso–Sept. 5500 w.

2407.—75 cts. Water Supply of Lynn, Mass. John C. Haskell (Paper read before the New Eng. Water Works Asso., Sept. 11, 1895. A detailed description without illustrations. Some of the points described are of interest to water works engineers and officials. Discussion). Jour New Eng Water Works Asso–Sept. 3500 w.

2408.—75 cts. A Short History of the Manchester High Service. Ill. Charles K. Walker (Paper read before the New Eng. Water Works Asso., Sept. 13, 1895. Includes not only an account of the initiation of this service and conditions leading to it, but also describes it). Jour N Eng Water Works Asso–Sept. 2000 w.

Miscellany.

*1952. The Prevention of Fires in Theatres. Ed. O. Sachs (From a paper introductory to a discussion at the Fire Congress held at Amsterdam. The author advises 1, planning; 2, watching; 3, inspection; 4, construction). Brit Arch–Oct. 4. 1100 w.

*2018. Municipal Ownership of Street Railway. I. Edward W. Bemis. II. Hartio A. Foster (The writers think, with the present spoils system, the immediate results might not be any great improvement; the ultimate results appear to favor such ownership. Reasons for this view are given). Elec Pow–Nov. 2500 w.

2035. The Proposed New Drainage System of New Orleans (Full description with map of a long needed work presenting unusual dfficulties). Tradesman–Oct. 15. 2800 w.

†2274 The Municipal Spirit in England. Robert P. Porter (An account of the changes that have taken place in the governing of the cities of England and Scotland and the system in London to day, with the prediction that town life of the 20th century will be as widely different from the 19th as this century differs from the 15th). N Amer Rev–Nov. 5000 w.

*2337. Recent Progress of Italian Cities. Albert Shaw (An interesting account of the Italian cities, their modern aspects, municipal system, sanitary laws, government, thoroughfares, street railways, gas supplies, water supplies, school system, building regulations, &c., &c.). Rev of Rev–Nov. 14000 w.

*2344. General Suggestions as to Parks and their Management. Edward Hill (Considers briefly the selection of site, method of procedure in surveying and designing as well as general management). Pav & Mun Eng–Nov. 1500 w.

*2345. The Park System of Boston. Sylvester Baxter (Condensed from the Boston Park Guide, written by Mr. Baxter. Description of the different parks and special features of each, with excellent half-tone illustrations). Pav & Mun Eng–Nov. 3000 w.

RAILROADING

The Train Speed Record Broken.

THOUGH the late record made by the N. Y. C. & H. R. R. R., in the run from New York city to Buffalo, was at a higher rate of speed than was made by either of the English roads in their competition, yet the excuse was given that the distance was less. The last run made by the Lake Shore and Michigan Southern Railway from South Chicago to Buffalo settled this point in a very satisfactory manner, breaking all previous records. *The Railway Review* (Oct. 26), in describing the run, says that this phenomenal trip "from South Chicago to Buffalo, 510.1 miles, at the rate of 63.614 miles per hour, including all stops, and at the rate of 65.073 miles per hour, excluding stops," was made by a special train of three cars. The engines selected were four 17 × 24-in. 8-wheel, and one 17 × 24-in. 10-wheel (with 5 ft. 6 in. drivers), each of the former weighing 104.000 lbs. with 80,000-lb. tender and having 65,000 lbs. on the drivers, while the weight of the latter was 114,000 lbs. "The train was composed of two parlor cars, weighing 92,500 lbs. each, and Dr. Webb's private car, weighing 119,500 lbs., making the total weight of the train back of the tender 304,500 lbs., or 152¼ tons." The passengers were principally officials of the road, who made accurate records of time and other items of interest.

The following summary gives the speeds over the several divisions:

		Miles	Av. running speed
Western Division		87.4	61.38
Air Line	"	133.4	64.25
Toledo	"	107.8	60,96
Eastern	" 1st half	95.5	67.01
"	" 2nd "	86.0	72 94
Total, Chicago to Buffalo		510.1	65.07

Less time was required in changing engines thanwould have been consumed in stopping to take water and coal. The changes were made in the times given in order: 2 min. 11 sec., 2 min. 28 sec., 1 min. 25 sec., and 2 min. 18 sec. There was also one flag stop of 2 min. 5 sec.

The trip over the last division is thus described: "At Erie a ten-wheeled engine was coupled on. This engine, No. 564, has 17 × 24-in. cylinders and drivers only 5 ft. 6 in. in diameter, but, if those who were watching the speed so closely had any misgivings as to the ability of such an engine to make fast time, they were soon set at rest. Engineer Tunkey, who handled the throttle on this division, said he was going to make a record, and he did it. . . . . The average speed on this division reached the remarkable figure of 72.91 miles per hour. But this does not tell the whole story, for 1 mile was made at the rate of 90 miles per hour, another at the rate of 92.3 miles per hour, and 33 consecutive miles were passed over at the average rate of 80.4 miles per hour. The total time from South Chicago to Buffalo Creek was 8 hours 1 min. 7 sec., and, as the total distance is 510.1 miles, the average speed is 63.614 miles per hour. The four regular and one flag stop sums up 10 minutes and 47 seconds; deducting this from the total time leaves 7 hours 5 minutes and 20 seconds as the actual running ime. This makes the running speed 65.-073 miles per hour, which is considerably greater than for any other long-distance run."

Racing Across the Continent.

APROPOS of the recent record-breaking feats in 500-mile runs comes the news from the progressive "West" of big reductions in time on the Chicago-San Francisco routes. According to the *Railway Age* (Nov. 1), the Southern Pacific proposes to increase its mile-per-hour rate from 33⅓ to 34½ miles. "And now comes the Santa Fé route into the field, with a California limited train service, running daily, which at one stroke cut off 12 hours from its previous schedule. . . . . As the course crosses four mountain ranges with long

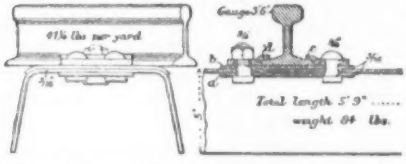
and heavy up-grades,—one stretch of 15 miles averaging nearly 175 ft. to the mile, and another of 25 miles averaging over 92 ft. to the mile, with others of less difficulty —it will be seen that to maintain such an average speed (30½ m. p. h.) means a far higher rate over favorable ground." It is stated that the Union and Central Pacific will join the race by cutting off 12 hours of its time. To show how the three great transcontinental routes to Los Angeles and San Francisco compare in distance and speed the following tabulated statement is presented.

	To Los Angeles.			To S. Francisco.		
	Miles.	Hrs.	Av.	Miles.	Hrs.	Av.
Santa Fé.....	2265	74	30.5	2577	....	...
Southern Pacific	2007	58	34.5	2489	75	33½
Union Pacific (via C. & N.-W.)	2712	106¾	25 4	2357	85¼	27.6

Steel Sleepers.

STEEL is the metal of the present, and, as economy in manufacture has made cheapness possible, we may look for its application to all construction where strength and wear are desirable considerations. Its application to railway work is increasing rapidly in rolling stock, signal, station, and permanent way construction. As an example of the latter, the *Iron and Steel Trades Journal* (Sept. 28) gives a description of the construction of the Normanton-Croydon Railway, North Queensland, in an excerpt from a paper by Mr. J. A. Griffiths, read before the Institution of Civil Engineers. The road is 94 miles in length, constructed in two sections. "The sleepers for the first section are herewith shown in Fig. 1. The body was bent cold

Figs. 1.

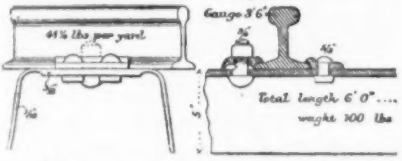


from a $\frac{5}{16}$-in. plate, and was strengthened inside and outside at the rail seats by plates *a* and *b* of the same thickness. The outer fixed clips *c*, determining the gage of 3 ft. 6 in., are attached by two ¾-in. rivets, and the inner removable clips *d* by a single ¾-in. bolt with a grip-nut and pear shaped neck fitting into corresponding holes in the trough-plates." The steel plates made in England by the Tredegar Ironworks were shipped to Brisbane. The plates were punched, cut, shaped, and prepared for laying, in the colony. The total number bent was 80,605, of 84 lbs. each. When finished, they were dipped in a boiling mixture of gas-tar and Trinidad bitumen. The fuel cost per sleeper (unnecessarily high) was:

	d.
Imported materials, including plates, bars, and bolts.....	53.62
Freight and charges, England to Brisbane	8.28
Toowoomba Foundry Company's contract for forming, providing rivets, and coating	21.50
Freight and lighterage, Brisbane to Normanton	22.27
Compensation for defective materials, &c.	2.94
" to shipping contractors...	1.93
Total cost.....	110.54

The sleepers used on the second section were slightly longer and heavier than those for the first section, the actual dimensions being shown in Fig. 2. Instead of strengthening the rail seats by plating, the whole of the top of the trough was rolled ⅜ in. thick, the vertical sides being $\frac{5}{16}$ in., as before. These sleepers were made by Messrs. P. & W. MacLellan, of Glasgow, and shipped direct to Normanton. Their final cost was:

Figs. 2.



	d.
Messrs. P. and W. MacLellan's contract.	90.00
Freight, lighterage, and charges.....	30.05
Total.....	120.05

The cost of preparation in Scotland was probably increased by substituting hot for cold pressing. Under more favorable conditions, steel sleepers of these patterns could probably be delivered at an Australian port for about the following prices. And these costs would admit of still further reduction in case of larger contracts.

Weight of tie	84 lb.	100 lb.
Steel at ¼d per lb.	42d.	50d.
Forming and coating	21 "	18 "
Freight	9 "	10 "
Total	72	78 "

It was intended that the sleepers should penetrate to half their depth below the original surface. The rate of progress in laying the steel sleepers on the first section was 5 miles per month, while on the second section it was 6 miles per month. The average progress per day was thirty-two chains, with a maximum of fifty-two chains. The average cost of the work in the earlier stages was £71 6s. 6d. per mile; when fifty-two chains per day were laid, the cost was reduced to £58 13s. 4d. per mile. It must be remembered that the gage was 3 ft. 6 in., and that very little excavation or embankment was required. In contrast with these figures, the cost of laying the short portions, including switches with wooden sleepers, was nearly 50 per cent. greater for labor, with the additional disadvantage of the future cost of relaying the wooden sleepers probably from five to six times during the life of the steel sleepers. The total cost of the railway is estimated at £2162 per mile for materials used, labor in construction, surveys, plans, and supervision.

In time of floods, it was found that the steel sleepers gave less trouble than wooden ties; 139 of the latter were renewed at the end of 3 years, on account of decay and the damage caused by white ants.

"The cost of maintenance for each season since the opening of the line, as given in the official returns, shows a steady decrease to a minimum of under £62 per mile per annum," and, comparing this with statistics from other roads, the author concludes that "it is probable that, in similar circumstances, the maintenance of the steel-sleeper road would be half, or less than half, that of a wooden-sleeper road." Corrosion has been small in amount, even where the line crosses a salt-water swamp. Altogether, the type of construction seems to be entirely satisfactory in this particular case.

The Fastest Train Runs.

SINCE the train speed record has been again broken, it is a matter of interest to know how the conditions in the several cases compared. *The Railway Master Mechanic* (Nov.) has made a tabulated summary, which is given below, and introduced it by saying that "so much that is inaccurate has been published regarding these recent fast runs that our readers will be interested in a comparison of the three, which we have endeavored to put in tabular form."

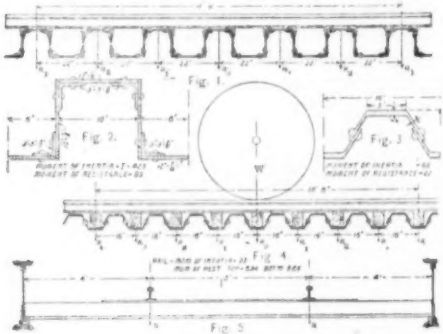
	Lake Shore & Mich. South.	N. Y. Central & H. R. R.	West Coast Route.
Date	Oct. 24, 1895.	Sept. 11, 1895.	Aug. 22-23, '95
No. of cars	3	4	8
Weight of cars	204,300	258,310 lbs.	150,080
Starting point	100th St., Chicago	New York	London
Finish	Buffalo Creek	East Buffalo	Aberdeen
Total distance in miles	510.1	436.32	539.75
Total time in minutes and seconds	461 m. 7 s.	411 m. 56 s.	512 m.
Average speed in miles per hour	63.614	63.55	62.25
Total time in motion	470 m. 20 s.	407 m. 41 s.	505 m.
Average speed, deducting stops	65.07	64.22	64.12
Length of division on which fastest average speed was made	86	145.6	141.25
Average speed on said division	72.92	65.75	67.50

The Railroad Gazette (Nov.) gives a more detailed statement, agreeing in the main with the above, except as to the item "Average speed deducting stops" on the West Coast route, which it gives as 63 93, instead of 64.12 as above stated.

Solid Floors for Railroad Bridges.

"THE practice in the use of solid floors in railroad bridges is extending in the United States quite as rapidly as one could expect. The theory has spread considerably faster than the practice, until now the objections which were heard only 5 years ago are seldom raised, and the advantages are pretty generally admitted." This is from *The Railroad Gazette* (Oct. 25), which gives an abstract from a paper by Mr. Henry Goldmark, read before the Western Society of Engineers and published in the

Jour. Assn. Eng. Societies. The chief advantage of the new system of construction is the absence of the liability of vibration or deflection. "A number of American roads have, within the past few years, begun the construction of solid or continuous floors of iron or steel, such as have been used for many years in England.



These consist, as a rule, of a series of troughs running transversely to the main girders, to which they are fastened. In some cases beams replace troughs, the beams being closely spaced and covered by a continuous steel plate, often with a ballast filling and timber cross-ties. Mr. Goldmark makes a calculation of the distribution of a single concentrated load throughout the different troughs of two types of floor system. The problem consists in finding out what proportion W is carried by the different troughs, so that, when this is known, the strains on the troughs and rails may be computed by the ordinary theory of beams. The following equations are deduced for the types of flooring shown.

Figs. 1 and 2.		*Fig. 4.*	
$R_0 =$	$.39\ W$	$R_0 =$	$.192\ W$
$R_1 =$	$.26\ W$	$R_1 =$	$.173\ W$
$R_2 =$	$.09\ W$	$R_2 =$	$.120\ W$
$R_3 =$	$-.045\ W$	$R_3 =$	$.080\ W$
		$R_4 =$	$.031\ W$

"The various reactions are represented by the letter R, with varying sub letters, as shown in the engraving. Having thus obtained the proportion of a single concentrated load carried by the different troughs, calculations may readily be extended to any system of axle loads desired. By combining the percentages of W thus concentrated on the different troughs, we find that the distribution of the load over all the troughs of the floor will be nearly uniform. These results enable us to compute the greatest strains likely to occur in any one trough with a degree of accuracy fairly comparable with that obtained in the other parts of bridges. The point as to the effect of an inefficient rail joint on the distribution of the load has been raised. Some computations have been made by the author with the joint plates supposed to be entirely removed. The results indicated that even in this case the maximum load on a trough is but slightly increased over the proportions tabulated above.

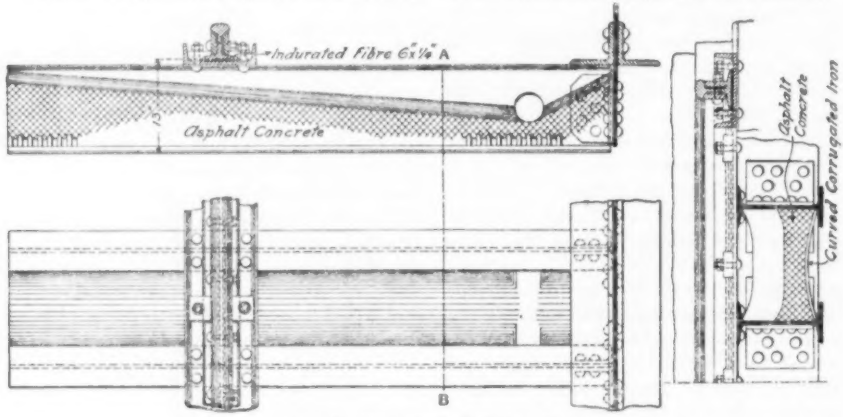


Fig. 6.—Horton's Solid Bridge Floor.

"Fig. 6 illustrates a floor designed by

Mr. H. E. Horton, which has many excellent features, as inspection will indicate. Indurated fibre is placed between the rails and the channels, as shown, and it is well drained."

Economy in Car Lubrication.

IN the appendix to a book on "Car Lubrication" by W. E. Hall will be found a series of tests made upon the Paris, Lyons & Mediterranean Railway, which *The Railway Review* (Nov. 2) quotes from as follows:

"LUBRICATING WICKS.—The tests made to compare the woollen wicks with those of cotton, in regard to the facility with which they supply the oil, have shown a superiority of delivery of from 50 per cent. to 100 per cent. in favor of the woollen wicks. It was also found that the renewals of the woollen wicks were only 68 in number compared to 100 of the cotton ones, and that the woollen wicks were less liable to firing. Notwsthstanding the higher price of the woollen wicks, it was found economical to use them, and since May, 1893, the Paris, Lyons & Mediterranean Company have adopted them entirely.

"BEARINGS.—The result of the tests made showed that the wear of white-metal bearings was 50 per cent. less than in the case of bronze bearings. The tests also showed that, by the use of white-metal bearings, a diminution of 20 per cent. on the resistance of fully-loaded coal wagons, forming trains weighing 500 tons, traveling at speeds of 16 miles to 26 miles an hour, was given; that, as the speed increased, this gain was diminished, but remained always 5 per cent. less. As a consequence of these tests, the Paris, Lyons & Mediterranean Company, in 1893, abandoned the use of bronze bearings for carriages and wagons, and adopted white-metal bearings.

"LUBRICANTS.—The tests made by abandoning carriages to themselves on a gradient have fully justified the rejection of grease by nearly all the railway companies, and the adoption of oil. Grease gave, for carriages isolated and mounted on bronze bearings, an increase of resistance per ton of:

"25 per cent. in comparison to mineral oil at low speeds (19 miles an hour);

"40 per cent. in comparison to colza-oil at low speeds (19 miles an hour);

"3 per cent. in comparison to mineral oil at high speeds (38 miles an hour);

"14 per cent. in comparison to colza-oil at high speeds (38 miles an hour).

"The increase of resistance would be greater in ordinary trains than indicated above for isolated carriages. From these same tests, combined with those made by means of the dynamometer cars, it was found, in comparing colza-oil, mineral oil, and mixtures of these two, that colza oil is more advantageous than mineral oil, and that the mixtures are classed between the two. Taking white-metal bearings, colza-oil, with an addition of 10 per cent. of shale oil, appeared to be very nearly equal to pure colza-oil in relation to non-resistance to traction; pure mineral oil gave, in relation to pure colza-oil, an increase of resistance per ton of 15 per cent. for trains of 300 tons, composed of fully-loaded coal wagons, and running at speeds of 16 miles to 26 miles an hour. The mixtures of mineral and colza-oil gave more resistance than pure colza-oil, and the increases of resistance were, in the same trains:

"13 per cent. for the mixture of 75 per cent. of mineral oil and 25 per cent. of colza-oil;

"7 per cent. for the mixture of 50 per cent. of mineral oil and 50 per cent. of colza-oil;

"3 per cent. for the mixture of 25 per cent. of mineral oil and 75 per cent. of colza-oil.

"It was also found that in summer the consumption of colza oil was only 0.8 of that of mineral oil. The tests were not made in winter, but it is presumed that then the consumption of mineral oil would be less. As a result of the tests, the Paris, Lyons & Mediterranean Company abandoned in 1891 the use of mineral oil, and adopted exclusively colza-oil with an addition of 10 per cent. of shale oil, the latter having the advantage of thickening less at a low temperature. The author estimates that in round numbers his company spent

in 1890 $3,200,000 in coal for the traction of their trains, and used 766 tons of lubricants. If mineral oil had been used in place of colza-oil, $320,000 more would have been expended on coal, and $61,250 less on oil, thus justifying, on the side of economy, the choice of colza-oil. Colza-oil is dark in color, and is sometimes known as rape-seed oil."

The Abolition of Fast Freight Lines.

As an editorial opinion on one of the means of simplying and economizing in railway freight service, the following is taken from *The Railway Review* (Sept. 28).

"The reported clause in the railroad presidents' agreement regarding the abolition of fast freight lines and their army of agents has provoked considerable comment, the burden of which appears to be that railroads cannot be well operated without them. A careful study of the fast freight line system of transportation fails to disclose any real need for their existence. Time was, before the freight business of the country was so organized as to permit of through shipments over connecting lines, as is now so common, when such organization filled a useful place. As compared with ordinary transportation by rail, they really were 'fast' freight lines. Through billing was an unknown quantity prior to the introduction of this system, and the delay incident to the transfer and re-billing of all freight at junction points was thereby obviated. But at the present time there is no difference in the rate of speed, or, so far as the movement itself is concerned, in any other particular, between property forwarded by fast freight lines, or by the road proper. . . . It should be understood that neither fast freight lines nor their representatives create any business; they simply divide it, and the contention that the roads would lose traffic by their abolition is pure nonsense.

"Perhaps the greatest objection to the fast freight line, aside from the question of rate demoralization, is the expense of maintaining the organization. This amounts to a serious tax upon the business, particularly in view of the low rates which obtain in the territory most largely traversed by these lines. When the average earnings per ton-mile was 2 cents and over, this item constituted but a small percentage, but, now that it is about ½ cent per ton-mile, the burden is too great to be viewed with complacency. Added to the direct expense attaching to this service are several other items, notably that of distributing and holding cars at various shipping points waiting for loads. It is by no means uncommon for a road to be obliged to haul the equipment of some other line 200 to 300 miles for the purpose of moving a shipment contracted *via* that line, when at the same time a half dozen empties of various other lines might be standing upon the side track at the shipping point. In the absence of fast freight line organizations, any available car would be used, provided it was loaded in the 'home' direction. Even under present rules, and in the event of the adoption of a car clearing-house, the car of any road could be employed." The editor deplores the necessity of dispensing with the services of a number of old and faithful employees with the abolition of fast freight organization, but offers the consolation that it would be a necessary action sooner or later.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Technical Journals—See Introductory.

*1890. The Cost of Railroad Construction. John F. Wallace (Analyzing the items of expense incurred in building different types of railroad, and showing the influence of time and circumstance in causing the variations therein. The subject is treated in detail, and includes statistics and tables of cost). Eng Mag-Dec. 3300 w.

†1901. The Street Railway Systems of Canada (Handsomely illustrated description of the Canadian roads, in the souvenir edition, issued on the occasion of the meeting of the American Street Railway Association, at Montreal, Can). St Ry Jour-Oct. 20000 w.

†1902. From Atlanta to Montreal.—A His-

We supply copies of these articles. See introductory.

tory of the Year. Ill. (Improvements in street railway practice during the past year, in the several cities of the United States, with numerous cuts illustrating new track construction and underground electric conduits). St Ry Jour-Oct. 4000 w.

†1904. Electric and Cable Car Trucks (Plan and side elevation drawings of both types, with some very interesting notes on their practical working). St Ry Jour-Oct. 3600 w.

†1905. Some Good Points in Car Building (Standards used by the J. B. Brill Co. Short description with two views of roof and reinforced corner). St Ry Jour-Oct. 1200 w.

*1908. Steel Sleepers in Queensland. John Alfred Griffiths (Excerpt minutes of Pro. of Inst. of Civ. Eng. A detailed description of the steel ties used, their manufacture, laying in place, cost of laying and maintenance and wear during five years). Ir & St Tr Jour-Sept. 28. 3800 w.

*1909. Street Railways of Montreal (Historical and descriptive. The special convention edition, printed in colors and handsomely illustrated). St Ry Rev-Oct. 6500 w.

*1910. Buffalo and Niagara Falls Electric Railway (Important inter-urban undertaking—built for heavy traffic and high speed. Description of plant and equipment, well illustrated). St Ry Rev-Oct. 2000 w.

*1911. The Mount Hamilton Incline Railroad at Hamilton, Ont. John Fensome (A counterbalanced 12-ft. gage railway, on a 45% grade. well illustrated by views and with detail specification). St Ry Rev-Oct. 1400 w.

1922. The Popp-Conti Compressed-Air Conduit System for Street Railways (Consists of a compressed air pipe between the tracks, having discharge mechanism at regular intervals, from which the air is fed in a few seconds stop, into the car reservoir, propelling car through a two-cylinder compound engine. Originated in Paris). Eng News-Oct. 10. 500 w.

1926. Cable Incline Railways of the World (A valuable article giving details of all the principal inclines in the world and a table giving all figures of interest). Eng News-Oct. 10. 1400 w.

1927. The Long Coal-Car Dumping Machine. Ill. (The car fastened inside a large cylinder, rolls with it and thus empties from the top. Built for the N. Y. P. & O. R. R. at Cleveland). R R Gaz-Oct. 11. 700 w.

1929. Street Railroad Postal Cars (Description of car, with plan and view of Postal Car on 3d Ave. Cable Road, N. Y. City). R R Gaz-Oct. 11. 300 w.

1930. Westinghouse Brake Trials in England (Editorial comment on some brake trials in England, with abstracts from *The Engineer* and *Engineering*). R R Gaz-Oct. 11. 1800 w.

1932. Taunton Sprinklers and Snow Plows for Street Railroads (Description with illustration of each). R R Gaz-Oct. 11. 800 w.

1943. Expanding Railway Earnings (September gross earnings point to a steady expansion in the volume of business done by the railroads. Tabulated statements of the gross earnings of 117 roads for Sept., and of the earnings and mileage for nine months). Bradstreet's-Oct. 12. 2000 w.

1958. A Plea for Electric Railways. Arthur Vaughan Abbott (A review of the mutual relations between the street railways and the public, and its usefulness in making homes possible for the masses considered). Elec Engng-Oct. 7300 w.

1963. The Mt. Clemens Fast Line; an Electric Interurban Road. Ill. (A road uniting Mt. Clemens and Detroit. A description of the road as completed. Portable telephone sets are used, each car being provided with one). Elec Ind-Oct. 700 w.

1979. Ex-Senator Edmunds on the Interstate Commerce Law (Abstract of an interview with ex-senator Edmunds, from the *Chicago Tribune*. It maintains that railways have taken a wrong position in their relations with the Interstate Commerce Commission, and that they know they are wrong. Incidentally it favors pooling). Ry Rev-Oct. 12. 1400 w.

1980. Standard Pilots. Ill. (The pilot adopted on the Chicago & Northwestern Railway, in order to facilitate repairing, as a substitute for the 100 different types in use). Ry Rev-Oct. 12. 1000 w.

1981. Train Shed of Reading Terminal at Philadelphia (Description of the structural peculiarities with section and details). Ry Rev-Oct. 12. 1500 w.

1983 Steel Rails of Heavy Sections Manufactured West of the Alleghenies. Robert W. Hunt (Paper presented to the Am. Inst. of Min. Eng. Showing the results of rigid inspection, and the specifications in full as now used, with some references to the standard rail sections of the Am. Soc. of Civ. Eng.). Ry Rev-Oct. 12. 3000 w.

1995. Ninety Miles an Hour. A New Style of Engine and What is Claimed for it. Ill. (To be placed on the Holman friction-geared trucks. Each of its driving wheels rest upon and between three other wheels that finally rest on the rails. The speed doubled by the use of this truck). Inv Age-Oct. 400 w.

1996. Development of Street Railway Apparatus. A Retrospect. Nelson W. Perry (An article of interest to electric railway men, giving an account of the earliest electric roads with specifications and bids). Elec-Oct. 16. 4300 w.

2002. The Use and Abuse of Transfers. J. B. Cohoon (Advises avoiding the use of transfers wherever and whenever possible. The best form is the limited transfer). Elec Wld-Oct. 19. 1800 w.

*2020. Electrical Details of the Metropolitan Elevated R. R., Chicago. Ill. Hugh Hazelton (A detailed description of the novel electrical features). Elec Pow-Nov. 1100 w.

2023. Organization of the Administrative Force of a Railroad (Extracts from the address of H. S. Haines, Pres. of the Am. Asso., Oct.

16, 1895, advocating the entrusting of considerable discretionary powers in the hands of officials in matters coming under their jurisdiction). R R Gaz–Oct. 18. 2000 w.

2024. Traction Tests on the Northern Pacific (Description of tests, with several diagrams and an inset, showing diagramatically the relation of grade, speed, and fuel to power required and also tests of the friction of various slide and piston valves. These are official tests and are both interesting and instructive). R R Gaz–Oct. 18. 1500 w.

2025. Roadmasters' Association of America (Reports of the committees on "Long Rails and Miter Joints," "Hollow Tires," "Joint Fastenings," "Track Tools," etc., read at the St. Louis meeting. They recommend long rails and miter joints; also that the wear on tires be within 1/16 in. for high speed, and 1/4 in. for all other engines, and also the adoption by the association of eight specified track tools as standard). R R Gaz–Oct. 18. 1300 w.

2026. Railroads and Their Employees (A paper presented at the meeting of the Am. Soc. of R. R. Supts., at New York, Oct. 14, by a special committee, C. R. Fitch, chairman. A report recommending careful selection of men, seniority giving place to superiority, strict and impartial but not harsh discipline, a "relief" system, and recreation clubs, but is doubtful as to premiums for good work). R R Gaz–Oct. 18. 1400 w.

2027. Some Facts Concerning the Use of Tie Plates. Benjamin Reece (Indicating that the tie plate is now a fixed factor in track construction, having passed beyond the experimental stage; with figures showing the extent to which the Servis plate has been adopted). R R Gaz–Oct. 18. 500 w.

2040. Changes in the Brooklyn Bridge Railway (Editorial discussion of the new terminal facilities, pointing out many undesirable features and criticising the present and proposed plans for switching and the adoption of electricity). Eng News–Oct. 17. 2400 w.

*2070. The Bristol Electric Tramway. Ill. (Full description. The opening of this tramway is considered important, and it is expected that it will have so important a bearing on the question of electric traction in Great Britain that history of traction in that country will be dated from its inauguration). Elec Rev, Lond–Oct. 11. 4500 w.

*2085. Comparative Advantages of Vignoles and Bullheaded Rails. James Whitestone (Communication advocating the superiority of the bullhead or double headed R. R. rail over the Vignole type of section, and predicting its future adoption). Eng, Lond–Oct. 11. 1200 w.

*2087. Single Driving Wheels in the United States (Editorial discussing the probability of the adoption of these engines on American railroads, giving high speed, small repairs to the large single wheel, but stating that they are not adaptable where starting a train is frequent). Eng, Lond–Oct. 11. 1800 w.

2096. The Joint Traffic Association (Full text of the agreement now under discussion in its present form, proposed for adoption for the various U. S. railways for the sake of uniformity in management). Ry Age–Oct. 18. 2000 w.

2097. The Southern Railway (The Southern Railway building and exhibit at the Atlanta exposition, with a description of the terminal arrangements and the rules governing the "Hall" automatic block system employed). Ry Age–Oct. 18. 2000 w.

*2109. Political Railway Control in New Zealand (Showing that the effects of government control have been quite unsatisfactory, with other facts of interest relating to New Zealand railways). Trans–Oct. 11. 1800 w.

2116. The E. M. Conduit Railway System. Ill. (Consists essentially of a conductor laid in sections flush with the pavement, midway between the rails, which sections are not part of the circuit, and hence are dead under normal conditions; only when a car approaches a section does it become live, remaining so until the car has passed over the section, when the latter is again disconnected from the live feeders and becomes dead; all these operations being performed automatically). Elec Eng–Oct. 23. 1600 w.

2117. Ties and Poles. N. W. L. Brown (Abstract of paper read at the Montreal convention of the A. S. R. A. Discusses the kinds of ties and poles in use, and recommends the use of creosoted timber). Elec Eng–Oct. 23. 2500 w.

2118. The Present Status of the Air-Brake. E. J. Wessels (A paper read before the A. S. R. A. at Montreal. The object of the paper is to call attention to air-brakes in general, applicable to passenger and freight, electric and cable cars). Elec Eng–Oct. 23. 2200 w.

†2134. Improved Tubular Bogie Wagon. Ill. (A 22-ton freight car designed for English roads, with special features of design: (1) the frame tubes are of one diameter; (2) all clamps are duplicates; (3) all channels and plates are of one section; (4) there are no special parts; (5) no steel frame exists with a less number of parts; (6) no parts are jointed). Ind & East Eng–Sept. 21. 1500 w.

†2135. Indian Railways, 1894–95 (Editorial. Abstracts from Commissioner Gracey's Administration Report, giving some interesting tabulated statements as to mileage, financial condition, expenses and earnings, with much detailed information). Ind & East Eng–Sept. 21. 1800 w.

2139. A Model Electric Railway Plant (Illustrated description of the plant of the Fairhaven and Westville electric railway). Sci Am–Oct. 26. Serial. 1st part. 1300 w.

2147. Lehigh Valley Wide Firebox Express Locomotive. Ill. (A design possessing many excellent features. Drawings and specifications). R R Gaz–Oct. 25. 800 w.

2148. The Transportation Show at Atlanta (Enumeration of exhibits, with some short descriptions). R R Gaz–Oct. 25. 1600 w.

2149. The Brake Trials on the Northeastern Railway of England (Showing the relation between speed, pressure and coefficient of friction, and comparing it with some American tests). R R Gaz–Oct. 25. 900 w.

We supply copies of these articles. See introductory.

2150. September Accidents (A general tabulated summary of accidents classified and compared for the month of September and which resulted in injury to persons). R R Gaz-Oct. 25. 500 w.

†2152. The Electric Railway System of Havre, France. Ill. (The first electric street railway installed in France. It comprises 40 cars, each first and second class, carrying a total of 50 passengers each. First class seats are plush covered, fare 3 cts.; second class of polished pine, fare 2 cts.). St Ry Jour-Nov. 1100 w.

†2153 New Cable Mail Cars for Third Avenue (Description illustrated by an interior and exterior view. There are eight cars in the service making sixty eight trips per day through New York City, facilitating the quickness of distribution of mails). St Ry Jour-Nov. 800 w.

†2154. Coal Handling System of the Buffalo Railway Company. Ill. (An automatic system of coal handling, consisting of four systems of conveyors, a storage tank, a traveling car distributing coal to the mechanical stokers, all operated by electricity. Two men now handle the plant, otherwise requiring 18 coal heavers). St Ry Jour-Nov. 500 w.

†2155. Electric Railway Notes From Europe. Ill. E. J. Wessels (The underground electric street railway under construction at Buda Pesth; a double track road with steel girder roof, handsome stations built of glazed tiles, all lighted by electricity and well ventilated. Also improvements at Halle, Leipsic and Chemnitz). St Ry Jour-Nov. 3000 w.

†2156. Wear of Wheels (Tabulated statements showing causes why street car wheels were removed in one city both for cable and horse propulsion). St Ry Jour-Nov. 500 w.

†2157. Load Diagrams in Boston (Curves showing the relation between amperes and number of cars and hours of the day, by tests on an electric railway). St Ry Jour-Nov. 200 w.

†2158. Report of the Committee on Patents to the American Street Railway Association. F. R. Greene and J. W. McNamara, Committee (Bringing to light the fact that many patents, now commanding royalties, would not be valid if tested, and making recommendations to the association). St Ry Jour-Nov. 2000 w.

†2159. Special Discourse on "Car Heating." Ill. J. F. McElroy (An excellent article on the methods of electric car heating stating among other things, that one person gives off 191 B. T. U. heat per hour). St Ry Jour-Nov. 4000 w.

2161. Number and Classes of Railway Employés (Editorial comment on the report of the statistician for the interstate railway commission, giving an itemized table of the total number of men employed in 1892, 1893 and 1894). Ry Age-Oct. 25. 450 w.

2162. The Fastest Long Distance Run on Record—510 Miles at 64 72 Miles an Hour (Account of a run made by a three car train on the Lake Shore and Michigan Southern Railroad, on Oct. 24, from Chicago to Buffalo). Ry Age-Oct. 25. 1000 w.

2179. The Taylor Motor Car Wheel. Ill. (A cast iron wheel with chilled flange and steel tread. Description of method of manufacture with advantages). Ir Age-Oct. 24. 500 w.

2224. New Terminal Station of the Brooklyn Bridge (History of the Brooklyn terminal station where the bridge cable line, two elevated road lines and the street car lines center, with a defense of the management). Eng Rec-Oct. 29. 1300 w.

2226. The Three Phase Railway System. Ill. (Description of the Lowell & Suburban Railway). Ry Rev-Oct. 26. 1200 w.

2227. Pneumatic Snow Flanger and Plow. Ill. (A small pilot snow plow attachment with "flanges" all raised and lowered by an air cylinder, designed to keep the track and flange ways clear of snow). Ry Rev-Oct. 26. 700 w.

2228. The Development of Electric Traction on Steam Lines (An editorial view of the possibility of substituting electric for steam power on our railroads. The immediate result is said to be the adoption of electric power on suburban lines, or the attempt to control such electric lines by steam power companies). Ry Rev-Oct. 26. 1300 w.

2229. The Fast Run on the Lake Shore from Chicago to Buffalo (The world's record for speed broken. A run with 3 car train, weighing 152¾ tons, from South Chicago to Buffalo, 510.1 miles, at an average speed of 63.614 miles per hour, or taking out stops, 65.073 miles per hour. Three different engines were used. Maximum speed was 92.3 miles per hour, and 33 consecutive miles were traversed at 80.4 miles per hour). Ry Rev-Oct. 26. 1500 w.

2238. The Removal of Grade Crossings in Buffalo, N. Y. Ill. (Discussion of the various proposed plans and history of the efforts to do away with grade crossings, with inset giving detail drawings of the improvements by the N. Y. C. & H. R. R. R. Specifications for this work were given in the issue of March 21). Eng News-Oct. 24. 3500 w.

2241. Management and Handling of Railway Motive Power (Abstract from the report of the Com. of the Am. Soc. of R. R. Supts. on (1) adaptation of locomotives to work they have to do; (2) economical loading of locomotives; (3) economy in fuel and supplies; (4) track and yard facilities; (5) how to obtain the maximum life service from a locomotive. It contains valuable information and suggestions). Eng News-Oct. 24. 1500 w.

2242 The Use of a Locomotive on Track Work. A. Morrison (Abstract of paper read before Am. Soc. of R. R. Supts. Specifying the various ways in which the engine of the repair train can take the place of hand labor, such as unloading rails, moving short rails on curves, moving turnouts, switches, etc., distributing ballast from the cars, etc. As an engine costs about $25 per day, it should never be idle but be utilized in every possible way). Eng News-Oct. 24. 1900 w.

2243. Specifications for the Boston Subway (Extracts from construction specifications for Section 2 of the Boston subway. Except in the case of cement specifications it embraces full de-

tails, including conduct and care of workmen). Eng News–Oct. 24. 1800 w.

2246. Track-Laying Machines for Street Railway Work. Ill. (A hoisting engine and swinging boom crane on a truck laying about 2200 ft. of track in a 10-hour day, at a cost of $5. The apparatus cost complete $1200. Illustration shows method of using). Eng News–Oct. 24. 700 w.

*2249. New Railways in Japan (Railway construction interrupted by the war, has again come to the front). Bd of Tr–Jour–Oct. 600 w.

2257 Deatto Conduit Railway System. Ill. (A new conduit system belonging to that class in which surface contacts with magnetic connecting devices are utilized). Elec Ry Gaz–Oct. 26. 500 w.

2258. The Staten Island Electric Railway. Ill. (A description of a complete, up to date suburban railway). Elec Ry Gaz–Oct. 26. 700 w.

2259. The Advance of the Electric Railway Motor. G. T. H. (Tracing the development and describing changes and improvements). Elec Ry Gaz–Oct. 26. 2300 w.

*2289. The General Railroad Situation. O. D. Ashley (The railway situation explained concisely and the remedy according to the writer's views is stated. He holds that the transportation and commercial interests of the country are identical and if one is disabled the consequences soon embarrass the other). Forum–Nov. 5000 w.

2295. Twenty-five Tons Capacity Wrecking and Construction Crane. Ill. (Supposed to be the most powerful standard gauge wrecking crane yet designed. They are made for the Boston & Albany, and the Norfolk & Western roads). Ry Mas Mech–Nov. 500 w.

2296. Tests of Single and Double Deflecting Plates (Report of a committee of the Southern and Southwestern Railway Club, giving the pyrometer and vacuum gauge readings, showing that the double draft sheet gave 13.2% more heat in the lower tubes). Ry Mas Mech–Nov. 800 w.

2301. The Trans-Siberian Railway. Ill. (Construction of the longest railway line in the world. It is a single track road costing about $165,105,250 and is built by the Russian government. The length is 4536 miles, while the Trans-Canadian line from Montreal to Van. cover is but 2760 miles). Sci Am–Nov. 2. 2000 w.

2316. Baltimore and Ohio New 60-ft. Postal Car (Description, with drawings, of a new Pullman car having an inside length of 60 ft., having 6 wheels trucks). R. R. Gaz–Nov. 1. 1100 w.

2317. Statistical Diagrams of the Interstate Commerce Commission (From the 7th annual report of Henry C. Adams. A series of 5 diagrams summarizing the statistics relating to equipment, capital stock, funded debt, passenger and freight traffic). R R Gaz–Nov. 1. 300 w.

2318. The Powell-Potter Automatic Signal and Safety Stop. Ill. (An automatic track device to prevent engines over-running danger signals by automatically applying the engine air brakes). R R Gaz–Nov. 1. 1600 w.

2319. An Electric Brake for Street Railroads. Ill. (A device utilizing the retarding force of the revolving armatures and the current generated by them in magnetizing an electro magnet which presses rubbers against a revolving disc fixed to the wheel axle. With editorial). R R Gaz–Nov. 1. 1200 w.

*2321. Improvements in Permanent Way on the Prussian State Railways. R. Goering (Excerpt Minutes of Proceedings Inst. C. E. showing the advantages of double headed rails over flat bottomed rails and submitting designs for chairs, keys, etc., with an outline of proposed improvements). Ir & St Tr Jour–Oct. 19. 1200 w.

*2327. The Glasgow Central Railway (The largest underground railway in Scotland. The location, construction and operation are described and illustrated). Eng, Lond–Oct. 25. 900 w.

2339. Wheels upon Wheels (An editorial discussion of the question as to whether railways should carry bicycles for passengers free of charge, concluding that they should not do so on strictly business grounds). Ry Age–Nov. 1. 600 w.

2341. The Railways of New South Wales and Queensland (showing a marked improvement in the financial condition of these Australian roads). Trans–Oct. 25. 2800 w.

2352. Belt-Rail Checking Machine, Grand Trunk Railway. Ill. (Description of a machine for checking or gaining of the belt rails for the passage of the posts in standard box cars). Am Eng & R R Jour–Nov. 1. 800 w.

*2357. New South Wales State Railways (Editorial comment on the report of the Commissioners showing the advances made against the effect of floods and drought and valuable statistical information). Ind & Ir–Oct. 25. 700 w.

*2361. A French Side – Hopper Ballast Dumping Car (An iron car 26×8 ft. inside measure, having three dump chutes to a side, having a capacity of 15 tons of stone or gravel ballast and dumping completely). Nat Car & Loc Build–Nov. 200 w.

*2362. Larger Freight Cars (An editorial stating that the Master Car Builders' Asso. have instructed their committee to prepare plans for a 40-ton capacity freight car, discussing the tendency toward larger capacity cars and the probable effects on road and equipment). Nat Car & Loc Build–Nov. 1500 w.

*2363. Exhaust Pipe, Chicago & Northwestern Railway. Ill. (Description of a contracted exhaust nozzle made according to the recommendations of a committee of the M. C. B. Asso). Nat Car & Loc Build–Nov. 600 w.

*2364. Washing Boilers with Hot Water (Description of method used on the Norfolk and Western R. R. using supplementary boiler and pump). Nat Car & Loc Build–Nov. 800 w.

*2365. The Management and Handling of Locomotives. W. F. Potter (Read before the Amer. Soc. of R. R. Supts , claiming that a lo-

comotive should be worked up to its capacity in order to attain its greatest economy). Nat Car & Loc Build–Nov. 1400 w.

†2366. The Railway Congress on Narrow Gauge Lines (Summary of the discussion before the International Railway Congress of St. Petersburg, giving examples in actual practice). Ind Engng–Sept. 28. 1100 w.

2393. Equipment of Rolling Stock with Automatic Brakes and Couplers (Reports of the Interstate Commission on progress made on coupler and brake equipment, in compliance with the requirements of law, showing that but little has been done to alter the present equipment). Eng News–Oct. 31. 700 w.

2397. Statistics of the Railways of the United States in 1894 (A review of the 7th Annual Report of the Statistician to the Inter State Commerce Commission for the year ending June 30, 1894. Though late the statistics are valuable and interesting). Eng News–Oct. 31. 1800 w.

2398. Electricity on Steam Railroads (Abstract of address by H. G. Prout at the 25th Annual Meeting of the Amer. Soc. of R. R. Supts. The theme of his address was to lay down some of the governing principles which would determine where electricity could and where it could not be used.) Elec–Nov. 6. 600 w.

2399. Storage Batteries for Railways. Maurice Barnett (The object of the paper is to emphasize the great value possessed by storage batteries—not in furnishing direct motive power, but when used in connection with railway power plants). Elec–Nov. 6. 1800 w.

2409. The Management of Railways. L. C. Fritch (Questioning whether the intellectual ability of the management has kept pace with the growth of railroading, and discussing the executive, constructive, and the managing ability of railroad men). Ry Rev–Nov. 2. Serial. 1st part. 1600 w.

2410. Grab-Irons and Draw-Bar Hights (Discussion at a meeting of the Western Railway Club upon the exact interpretation to be put upon the law requiring grab irons on all freight cars and fixing the height of draw-bars. The latter was fixed by letter ballot at from 31½ to 34½ inches above the rail). Ry Rev–Nov. 2. 1700 w.

2411. The Economy of Good Lubrication (Results of a series of tests by the Paris Lyons & Mediterranean Railway Company which led to the abandoning of grease and mineral oil as lubricants and the adoption of colza oil: also the substitution of white metal for bronze, and woolen for cotton lubricator wicks). Ry Rev–Nov. 2. 1200 w.

2423. Railroads as Manufacturers. From *Locomotive Engineering* (Discussing the manufacture by railroads of their own supplies as not being economical, and citing examples indicating that such manufacture is carried on simply as an expedient). Ir Age–Nov. 7. 900 w.

2434. Rail Making in England (A letter to the editor referring to Mr. Hunt's article on rail specifications, comparing them with similar ones in use in England and enclosing specifications made by Indian railways for English rails of flat-footed section. He believes that the English make a rail superior to those of American manufacture. Also editorial). R R Gaz–Nov. 8. 3000 w.

2435. Steam and Trolley in Connecticut. Clarence Deming (A detailed account of the struggles and competition between steam and electric passenger lines in Connecticut, with map showing location of established and projected roads. Less than 75 miles of new track have been laid on the steam roads since 1875. Showing also the concentration of population along transportation lines and the probable effect of the new law compelling electric lines to own their own roadways). R R Gaz–Nov. 8. 3000 w.

2436. The B. & O. Electric Locomotive (Late pulling records showing the locomotive equal to the greatest load it will be called upon to handle. The greatest pull thus far was two coupled trains 1800 ft. long, and weighing 1900 tons giving by a dynamometer test a draw bar pull of 60,000 lbs., or an average of 40,000 lbs. at the speed of 12 miles per hour). R R Gaz–Nov. 8. 800 w.

2437. A Glimpse of the Exhaust Jet. William F. M. Goss (A paper read before the Western Railway Club on a device employed in the laboratory of Purdue University to define the form of the exhaust jet by means of anamometer tubes whose apertures can be placed anywhere in the jet of steam). R R Gaz–Nov. 8. 1500 w.

2438. The Air Brake on Freight Trains—A Chapter of Experience (This editorial shows that on the N. Y. C. & H. R. R. R. the controlling of freight trains by air brakes, has saved the company in brakemen's wages alone, over and above cost of brake repairs, maintenance, and fixed charges at least $15,000. On the Lake Shore route the average speed has been increased by 30 per cent. due to the same cause). R R Gaz–Nov. 8. 1100 w.

2439. The Best Railroad Speed Records (A compilation of some remarkable railway runs with explanation of the conditions under which they were made. The longest run, Jersey City to Oakland, a distance of 3311 miles was made at the average rate of 39.53 miles per hour. The quickest run was by the N. Y. C. & H. R. R. R., a distance of one mile at the rate of 112.50 miles per hour). R R Gaz–Nov. 8. 1300 w.

2440. Details of Interlocking Apparatus on the Michigan Central. H. D. Miles (Paper read before the Railway Signaling Club, condensed. The paper deals only with such methods as are peculiar to the Mich. Cent. Railroad, such as concrete foundations for signal connections, galvanized pipe leads to signals, etc). R R Gaz–Nov. 8. 2300 w.

2444. Losses in the Operation of Electric Railways. Herman S. Hering (Losses not usually referred to which have been investigated by the writer, such as those due to defective roadway construction, to the manner of handling the controller, to stopping and starting, and to carrying additional dead weight on the car). Elec Wld–Nov. 9. 3300 w.

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

The Solar Magnetic Problem

THE status of "the general problem of the transference of energy from the sun to the earth" is well outlined in a paper by Frank B. Bigelow (*Science*, Oct. 18). Much has been written and said upon the subject during the past 4 years. In this paper Mr. Bigelow gives a summary of present progress toward a solution of the problem, which is fundamentally important, since the sun is undoubtedly the source of all terrestrial energy.

The peculiar difficulties which have hitherto prevented definite conclusions do not arise from obscurity in the line of operations, or from mathematical intricacy, but from what Mr. Bigelow calls "looseness of the phenomena"; and he explains that by "*looseness* is meant the wide deviations from the normal laws, whatever these may be, arising from the actual spasmodic actions of the sun on the one hand, and the very indirect effect of the solar energy thus generated upon the terrestrial, magnetic, and meteorological fields, as recorded by the instruments employed in observations. This is an ordinary difficulty when the ether is the medium of the transference of energy between masses of matter widely separated in space, and in our case it is especially complex by reason of the complicated nature of the transmitter and the receiver,—namely, the sun and the earth respectively." This reduces the work of solution to "a system of approximations," while "the complication of terms is so great that it is only by the successful treatment of an enormous mass of material that the impressed force desired will emerge by the mutual destruction of other terms."

The weather bureau hopes, by increase of knowledge upon this subject, to improve its forecasts. "Meteorology has contented itself with combinations of three forces—the earth's gravitation, the earth's rotation, and equatorial insulation—acting upon the fluid atmosphere, in order to explain the observed effects in the motions of the air. The result has not satisfied students of the subject. The first point to determine was whether the sun did or did not transmit other energy to the earth, and, if it did, what kind of energy. The probability was that the auroras, the magnetic storms and earth currents, certain spasmodic actions in the electricity and magnetism of the earth's field and motions of the atmosphere, the sun spots and the coronal output, all belonged to one fundamental system, though no intelligible notion had been proposed that could explain the interrelation philosophically. The great distance of the earth from the sun seemed a barrier to one obvious explanation, so that the work was never seriously undertaken to test the validity of it."

Mr. Bigelow's own researches upon the stream-lines seen in the corona during a solar eclipse "suggested and strengthened the working hypothesis that the whole unexplained system might be referred to the sun as a magnet in dynamic operation, and that live lines of magnetic force originating in the sun were propagated to the earth in wide sweeping curves, where the energy was expended in various operations, such as those just mentioned."

He does not doubt "that a complex field of mechanical forces, besides gravitation," surrounds the earth at its surface. "In order to distinguish the field of force that was supposed to produce the aurora and the other phenomena above mentioned, it was proposed to call it 'coronal,' or 'polar' radiation, in distinction from the sunlight, or equatorial, radiation. It is radiation of some kind, if there is any transmission of energy through the ether from the sun to the earth, and it may be simply magnetic or curved radiations, as opposed to rectilinear, or electro-magnetic radiation, the latter having been practically established as natural by the work of Maxwell and Hertz."

Passing what is said upon the synodic

period (found to be 26.68 days) representing the solar field at the distance of the earth, and the classification of hitherto unworkable data to which this determination has led, we come to the following interesting summary.

"On the earth it has been shown that the permeable magnetic material is confined to a shell about 800 miles thick; that, in consequence of this, the external field divides into an exflected system, accounting for the location and movement of the auroral belt, and an inflected system, in some way related to the energy of the tropical hurricanes; that the lacking term needed to account for the spasmodic action of storm generation over our entire hemisphere is to be attributed to the solar field; that the storm tracks of the United States vary in latitude and the eastward drift of storms in longitude; that the storms are formed in the northwest in a procession corresponding to the type prevailing, and that this order is inverted with the type; that the maximum of extra-tropical storms of America, as compared with Siberia, is due to the impression of this variable energy upon the atmosphere in North America; that the prevalence of storms and cold waves in winter is due to the increased action of the magnetic field at lower temperatures; that the glacial epochs may naturally be referred to the long period variations of the sun as respects its magnetic output; that the observed minute variations of terrestrial latitudes may be plausibly ascribed to the action of the stresses in the ether at the surface of the earth, due to the mechanical forces generated in the ether by the transmission of radiant energy."

In conclusion, the desirability of magnetic observations in the northern Rocky mountains upon "the interrelation of several primary physical forces" is indicated. "The high altitude of this region, bringing the stratum in which observations are made more nearly into contact with the external field, and its proximity to the polar magnetic cap, suggest that it is the most appropriate place for the establishment of a magnificent, permanent, solar terrestrial observatory, equipped with the best instruments available, and managed by men of power in scientific investigations. One such observatory in the northwest and another in the eastern part of the United States, together with some minor stations, would no doubt amply repay the American people for the expense of equipping and maintaining them through the agency of the government."

Commercial Manufacture of Liquid Air and Oxygen.

A PROCESS invented by Mr. Linde of ice-machine fame is now in the experimental stage. The successful production of liquefied air and oxygen by this process appears to be well established; the experiments are now directed to developing a commercial value for the process. The industrial applications which liquid oxygen may find in the arts are, as yet, wholly a matter of conjecture. However, it seems reasonably certain that the new process may be carried on as a commercial enterprise, should such applications create a demand for it.

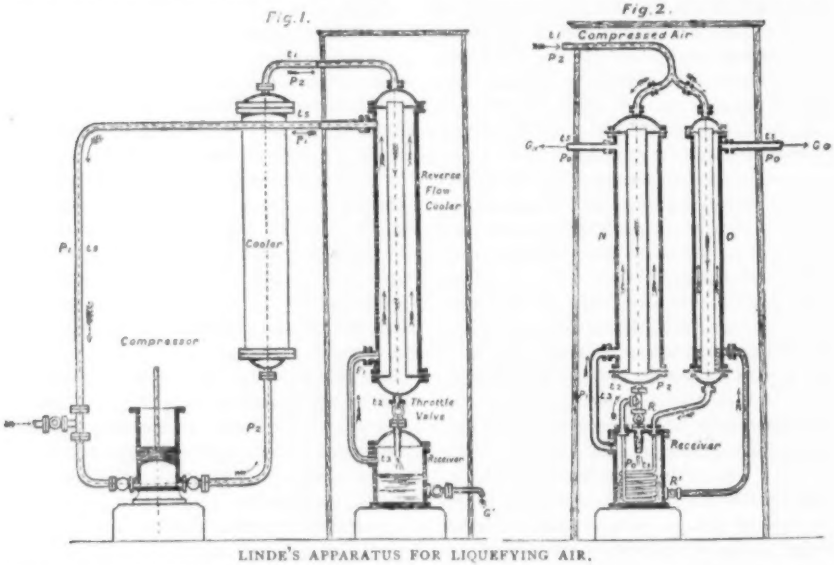
The cuts show diagrammatically the nature of the apparatus employed for the purpose, and we make an abstract of the description of the apparatus and process from a paper read by Herr M. Schroter before the German Engineers at Aix, a translation of which is printed in *The Engineer* (London, Oct. 14).

"It is generally assumed that, in the case of a cold-air machine, it is essential that the compressed air shall, in expanding, do work, for otherwise,—there being no change of state, as the air is far above its critical point—the final temperature after expansion, when all parts of the system have attained equilibrium, will be equal to the initial temperature, and no cooling will be effected. This is not strictly correct, for it presupposes that air is a perfect gas, in which no intermolecular work is possible. It is true that the amount by which air departs from the behavior that may be postulated for a perfect gas—an imaginary entity—is not great, but it is perceptible, and—what is more—was measured by Joule and Thomson 40 years ago. These experimenters found

that, dispensing wholly with a cylinder in which compressed air could do work, and using only an outlet in the manner practised for freezing machines using easily liquefiable gases, the air was definitely and permanently cooled.

"This cooling effect is so inconsiderable that it appears at once that a cold-air machine with merely a throttle valve, and without an expansion cylinder, would be a valuable contrivance. It is, therefore, the more remarkable that Linde, the inventor of the apparatus shown in Figs. 1 and 2, should have been able to utilize this small difference in such a way as to cause it to yield a cumulative effect great enough to permit the attainment of the critical temperature of air, and, as an immediate and necessary consequence, of temperatures still lower, —*e. g.*, —200 deg. C.=—328 deg. F., by simply handling liquid air like any other volatile liquid."

Referring to Figs. 1 and 2, P_1 is the inlet, and P_2 the outlet, pipe of a compressor. The compressed air is cooled to about 14 deg. C.=58 deg. Fah. by an ordinary water-jacket marked "cooler" in the figure. The air then passes down the "reverse flow cooler" shown on the right-hand side of Fig. 1. It will be seen that connection with the outer annular space of this cooler is entirely cut off by a diaphragm at each end. The air flows through the throttle valve and expands, doing work and becoming slightly cool. Thus, with a pressure of seventy-five atmospheres on the upper side of the valve, and one of twenty-five atmospheres on the lower, air at an initial temperature of 10 deg. C. is cooled through —12.76 deg. C., in accordance with Joule and Thomson's



LINDE'S APPARATUS FOR LIQUEFYING AIR.

formulæ. The slightly cooled air flows by the side tube leading from the "receiver" —see Fig. 1—into the annular casing of the "reverse flow cooler," its course being indicated by the direction of the arrows. In thus flowing, it receives heat from the air streaming along the inner tube in the contrary direction and about to pass the throttle valve, which is correspondingly cooled. This cooled air in its turn passes the throttle valve, and is again cooled by its expansion, and serves to cool the next portion about to pass the throttle. The air flowing upwards is, at the point where it enters the annular case, at the low temperature attained a moment before by passage through the throttle, and the air on the point of passing the throttle is at the temperature which the portion next

before it has reached by its own passage through the throttle. A gradation of temperature from the lower to the upper end of the "reverse flow cooler" obtains in both the inner and outer sections thereof, and at the upper end both streams of air are substantially at the same temperature,—*viz.*, that fixed by the water jacket through which the delivery pipe of the compressor passes. The return current of air passes at this temperature back to the compressor, and is there driven once more through the system, heat due to the stroke of the compressor being taken up by the water jacket, so that air at a temperature not higher than 10 deg. is constantly delivered to the upper end of the inner tube of the reverse flow cooler. In practice, this most essential portion of the apparatus—shown for simplicity as two straight concentric tubes (see Fig. 1)—consists of two spiral tubes, one within the other, 100 m. long and 10 and 4 cm. in diameter respectively. The whole is, of course, elaborately lagged, to prevent the absorption of heat from external sources. The cycle of operations, consisting of compression, expansion, and cooling, continues until the temperature of the air in the apparatus falls in the receiver to a point bebelow the critical temperature of air. A portion of the air thereupon liquefies, and a fresh quantity is accordingly introduced into the system by a second compressor,—not shown,—which serves to feed the main or circulating compressor. The process continues as before, until a sufficiency of liqud air has collected in the reeiver.

From the known relations of adibatic compression of gases, it is evident that, for attainment of economy, very high pressures must be used, and that the difference between high and low pressure must be great, while the ratio of compression remains small. A high pressure of one hundred and fifty atmospheres and a low pressure of fifty atmospheres, the ratio being one to three, satisfies these theoretical conditions. Such pressures are already successfully managed in torpedoes, and in hydrogen cylinders for balloons, and it is not anticipated that, in carrying out the new process, any greater difficulties will present themselves than have already been met and surmounted.

Birds in Flight and the Flying Machine.

To those interested in aeronautics, as inventors or constructors of flying machines, or as investigators of the attractive subject of the *modus* of flight, Mr. Hiram S. Maxim's article on the subject in the *North American Review* (Oct.) will be very interesting reading. He adopts the view that, in soaring, birds avail themselves of upwardly-flowing air currents in such manner that, though in the act of soaring they are sliding downward relatively to the body of air in which they are soaring, the upward movement of the aerial mass neutralizes the effect of this sliding relatively to the earth. He illustrates this view of the subject as follows:

"The soaring of a bird may be compared with a boy sliding down hill on a sled. If a hill is, say, 100 ft. high, and the sides slope off in a horizontal direction 2000 ft. from the summit, and if the snow is smooth, a boy can mount a sled and advance 2000 ft., while he is falling, as relates to the earth, 100 ft.; that is, the sled with the boy on it, in falling through a distance of 1 ft., develops sufficient power to drive the sled forward 20 ft.; but, when the boy is at the bottom of the hill and can develop no more power by falling, the sled soon comes to a state of rest. Suppose, now, that a hill could be made in such a manner that it would constantly rise at such a velocity that the sled would never reach the bottom of the hill, the boy would then be able to slide forever; and this is exactly what occurs with a bird. A bird places its wings in such a position that, as it falls in the air say 1 ft., it moves forward through the air 20 ft.,—that is, slides along on the surface of the air underneath its wings in the same manner that the boy slides down the hill. Suppose, now, that the velocity of the bird should be about 30 miles an hour, this would account for the whole phenomena of soaring on an upward current of only 1½ miles an hour. With an upward current of 2 miles an hour the bird would rise, as relates to the earth, ½ mile an

hour, while actually falling through the air at the rate of 1½ miles an hour. There is no doubt that a bird, by some very delicate sense of feeling and touch, is able to ascertain whether it is falling or rising in the air."

It does not seem to us necessary to account for the fact that a bird knows when it is rising or falling by its sense of feeling. Sight of objects on the surface of the earth would enable it to determine this, in the same way as the relative apparent change of position of objects at different distances on a visible shore enables a boatman to determine, not only that his boat is moving, but also the direction in which it moves, and whether the motion is slow or rapid.

Mr. Maxim thinks (basing his opinion upon his own observations of air currents) that the rising columns of air are "half of the total area of the earth's surface, so that a soaring bird would always have a rising column of air which would serve as a support."

An account is given of very interesting personal observations of rising and falling air currents over the Atlantic ocean, the Mediterranean sea, and in mountainous regions. Speaking of observations of the flight of eagles in the Pyrenees, he says: "On one occasion I observed five of these birds about 500 ft. above the peak of a mountain, and they were balancing themselves in a stationary position on an ascending column of air produced by the wind blowing over the peak, and seemed to be as much at ease as if they were roosting upon a tree. With the albatross and sea-gull, it will be found that they always occupy the same position as relates to the ship. As the ship passes through the air, the air is divided exactly in the same manner as water would be, and, as it comes together again at the stern of the ship, it produces an upward current, and it is on this ascending column of air that the albatross and the seagull find a resting-place and follow the ship, for days at a time, without any apparent exertion; but, whenever they find themselves in front of the ship, or at one side, where there is no ascending column of air, they have often to work their passage very much as other birds do.

"But all birds do not soar. Ducks, geese, partridges, and pheasants are types of birds which are provided with comparatively small wings. They only remain on the wing for a short time, and, while in the air, exert an enormous amount of energy and move at a very high velocity. They do not seem to have the power to take advantage of ascending columns of air, but move in a straight line, quite independent of air currents; and it is these birds we should seek to imitate in our attempt to navigate the air."

Mr. Maxim admits that no previous theorizing upon the soaring of birds has been entirely satisfactory, and does not expressly claim that his own theorizing makes it altogether clear how birds of certain kinds can sustain themselves in the air and traverse such great distances as they are seen to do without apparent effort; but doubtless this theory is a clue which, if pursued intelligently, will lead to more accurate conceptions.

A New Smokeless Powder.

IT may not be amiss to say, as a preliminary to a review of an article on this subject in *Engineering* (Sept. 20), that smoke is not gaseous, as it is often unscientifically considered, but a cloud of solid particles suspended like dust in the air. Anything that burns completely into a gas generates no smoke. Efforts have long been made to produce powder that will not produce smoke in burning. Not only in the military art, but in mining and quarrying, is such an explosive desirable, provided that, for the latter purpose, the gases produced shall not possess materially deleterious properties. For military purposes it is also necessary that the powder should have good ballistic power, and that the chemical action of the gases upon the material of which gunbarrels are made shall not be injurious. A number of smokeless powders exist, but they do not all meet these necessary requirements.

The new smokeless powder produced in the United States by Mr. Hudson Maxim and Dr. Robert Schupphaus is that con-

sidered in the article reviewed, and both its remarkable ballistic results and its novel character and appearance are attracting public attention.

"Experience in the use of smokeless powders has developed many things not at first anticipated, and the knowledge from which have been evolved the best powders of the present time has been costly of attainment. Formerly the main object was to secure high ballistic results. The importance of the effect of the gases of combustion upon the bore of the gun was not understood, but, as powders containing very large percentages of nitro-glycerine were introduced, and many large and valuable pieces of ordnance were destroyed, the dangers arising from erosion were realized. At the present time nothing less than a stable explosive compound adaptable to guns of all sizes, which will produce as high ballistic results as possible, and will work with a minimum injury upon the gun, will satisfy artillerists.

"The Maxim-Schupphaus powder consists of about 90 per cent. pyroxylin or gun-cotton, possessing a very high degree of nitration, with about 9 per cent. of nitro-glycerine and from ½ to 1 per cent. of urea. It is a true colloid, being perfectly amorphous or structureless, and exceedingly hard and horn-like. The powder, which is made in relatively long cylinders, is perforated axially with a large number of small holes, so that a minimum of burning surface is presented to the initial flame of combustion, and a comparatively low initial pressure is secured. As, by burning, the perforations increase in diameter, the combustion surface and consequent evolvement of gases is greatly extended, so that the pressure is well maintained throughout the bore of the gun, and a maximum of propulsive energy is secured to accelerate the velocity of the projectile."

The Maxim Schupphaus consists preferably of nine-tenths gun-cotton, the other ingredients being those of nitro-glycerine. Its high ballistic power appears to result more from the form of perforated cylinders described than from its composition. In the United States government tests of the powder at the Sandy Hook proving-grounds, some of the velocities obtained were remarkable, in contrast with the low pressures generated. A velocity of 2403 foot-seconds with a pressure of 30,600 lbs. was reached in one of the tests, thus exceeding the government requirements about as five to three. *Engineering* concludes that "the difficulties hitherto encountered in the manufacture of a smokeless powder for large guns in the form of a colloid, consisting chiefly of gun-cotton in the highest degree of nitration, known as tri-nitro-cellulose, seem to have been removed by Maxim and Schupphaus; and the high ballistic results heretofore thought obtainable only with a compound containing from 50 to 70 per cent. of nitro-glycerine have been exceeded by a compound containing only 9 per cent. of nitro glycerine."

A New German Lamp.

THIS new lamp, according to a description of it given by Mr. Charles de Kay, consul general at Berlin, in *Consular Reports* for September, has a mantle, like the Welsbach lamp, but, instead of using ordinary illuminating gas as the agent by which the mantle is heated to incandescence, the fumes of potato spirit (chiefly amylic alcohol) are employed. It is stated that the recent rise in the price of petroleum in Germany has strongly attracted attention to this invention. Potato spirit can be very cheaply produced, but its smell is very offensive, and its fumes are highly poisonous. A lamp for using this fuel must have a safeguard against the escape of these fumes into the surrounding atmosphere. The lamp is thus described: "In order to induce the fumes to rise from the spirit into the incandescent 'hood,' a hollow metal rod with two elbows like an inverted U is arranged over the bowl of the lamp so that the two arms descend to the fluid; a wick is passed through the arms, and underneath each arm is placed a simple straight tube with a wick, which also descends to the spirit. As soon as this wick is ignited, the long arms begin to get warm above it, and the fume of the spirit begins to assemble in the bent tube and pass up through a sm

hole on the upper side into the hood, where it can be ignited. To quench the light, it is only necessary to blow out the little wick below the bent tube, whereupon the latter gets cold, gas ceases to form, and the incandescent hood above ceases to operate. At present the cost of this lamp is too great to warrant a wide use of it. A complete lamp costs about $5, and the apparatus to be adjusted to a petroleum lamp costs about $3. But these prices are sure to fall rapidly, if the public takes to the invention. Another drawback is the danger of explosions.

THE ENGINEERING INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Technical Journals—See Introductory.

*1916. Geological Research and Undiscovered Stores of Water and Coal (Extracts from the inaugural address of W. Whittaker and from addresses by J. Francis and F. W. Harmer before the Geological Section of the British Asso. Consideration of how far the sinking of wells has furnished information which will assist the geologist in the search for coal in South-Eastern England). Jour Gas Lgt-Oct. 1. 3000 w.

1928. The Vulcanizing Process of Preserving Timber (Effect of heating timber under pressure as observed in railroad ties and in bridge timbers). R R Gaz-Oct. 11. 1100 w.

1935. The Arctic Expedition of 1895, and Lieutenant Peary's work. Rollin D. Salisbury (The writer thinks that although adverse circumstances made it impossible for Lieut. Peary to carry out, in full, his plans with reference to the north coast of Greenland, he accomplished much during his Arctic residence. He cites briefly some of the scientific results). Science-Oct. 11. 1200 w.

*1961. Louis Pasteur (A brief biographical sketch and obituary). Nature-Oct. 3. 1700 w.

*1970. The Commercial Manufacture of Liquid Air and Oxygen (Discussion of a process of liquifying air and obtaining oxygen on a commercial scale, by purely mechanical means. Invented by Lind, of ice-machine fame. Illustrations of the apparatus with full description and explanation of this remarkable achievement are presented, with editorial comments). Eng, Lond-Oct. 4. 3500 w.

2006. New Flying Machine. Ill. (Inventions of Mr. Percy S. Pilcher. Light structures of wood and steel supporting a vast spread of wing and braced with piano wire). From *Black and White*. Sci Am-Oct. 19. 400 w.

2015. The Tussah Silk Industry. From *La Nature* (An interesting popular description of this industry with illustrations of apparatus and processes). Sci Am Sup-Oct. 19. 1400 w.

2016. On the Electrolysis of Gases (Experiments wherein the spectroscope was used to detect the decomposition of gases by electric discharge and the movement of ions in opposite directions along the tube. First number describes process, apparatus, and manipulations). Sci Am Sup-Oct. 19. Serial. 1st part. 2800 w.

*2043. Mr. Vernon Harcourt on Gas Production and Consumption (A lecture delivered to the students at New Cross, London. Describes materials from, and methods by which gas is made, and appliances for burning it). Jour Gas Lgt-Oct. 8. 3000 w.

*2045. Powder Making on the Pacific Coast. Ill. W. C. P. (Popular description of the mills of the California Powder Works, with illustrations of machines, processes, products, and different fire-arms for which the different kinds and grades of powder and cartridges are adapted). Overland Monthly-Oct. 3500 w.

*2046. Smokeless Powders for Shotguns. Ill. W. L. Colville (A popular account of the composition and characteristics of gunpowder, including smokeless powder, with a historical sketch of the manufacture of gunpowder in the United States). Overland Monthly-Oct. 5000 w.

2072. A Course in Astronomy for Engineering Students. George C. Comstock (Stating the author's conception of a brief course in spherical and practical astronomy as a part of the technical training of the future engineer. He considers such a course important to every engineer in whose work surveying is to occupy an important place). Science-Oct. 18. 2300 w.

2073. The Status of the Solar Magnetic Problem. Frank H Bigelow (It is proposed to summarize the evidence already obtained, and to indicate the nature of the scientific questions immediately at hand, bearing upon the transference of energy from the sun to the earth). Science-Oct. 18. 2800 w.

*2074. The Ice-Avalanche on the Gemmi Pass (Switzerland). C. S. Du Riche Preller (Descriptive of the avalanche on the Gemmi Pass in 1894 and computation of the work of the fall, result 4,400,000,000 meter-tons). Engng-Oct. 11. 1300 w.

*2107. Alkali Manufacture F. W. S. Chenhall (Chiefly historical). Chem Tr Jour-Oct. 12. Serial. 1st part. 2500 w.

2128. Simond's Electrical Pyrometer. Ill. (Description of this instrument now coming into use for hardening and tempering steel, as well as for all purposes wherein high temperatures need to be indicated). Am Mach-Oct. 17. 300 w.

2175. Helium and Argon. H. N. Stokes (Speculations based on recent observations of these substances, with account of where found and what has thus far been learned concerning them). Science-Oct. 25. 3300 w.

2176. Economics of Engineering

We supply copies of these articles. See Introductory.

Works. Henry N. Ogden (Extravagance of the Americans as shown in way of living and in corporations and associations seeking their own advantage at the expense of the public good. Instances cited). Science-Oct. 25. 2800 w.

†2195. Solutions. A. W. Connor (An able discussion of what has until recently been one of the most obscure branches of physics. Recent development has thrown much new light upon the subject, which is embodied in this very valuable paper. Chemical and physical agencies and their mathematical relations to solutions of various substances by other substances are thoroughly treated). Eng Soc of School of Prac Sci-No. 8. 7000 w.

*2204. Phenomena and Research. G. Johnstone Stoney (Abstract from an article on "The Kinetic Theory of Gases, regarded as Illustrating Nature," in the *Phil Mag.* Oct. 1895. Methods of investigation with an outline of the principles). Elect'n-Oct. 18. 1600 w.

*2205. Note on the Effect of the Glow-Discharge on Oxide of Lead. E. Warburg in *Wied Ann.* (Descriptive of experiments). Elect'n-Oct. 18. 1000 w.

*2248. The India Rubber Industry in South America. From the *South American Journal* (An account of the industry and cause of the threatened famine in India-rubber). Bd of Tr Jour-Oct. 1200 w.

2303. The By-products of Slaughter Houses. Ill. (Describes the method of slaughtering animals for food, and the purposes for which inedible parts are utilized in industry). Sci Am Sup-Nov. 2. 1700 w.

23 8. The Commercial Value of Photometry. Alex. C. Humphreys (A very thorough and exhaustive paper of unusual scientific and practical value, with an appendix containing an excellent bibliology of both standard and recent literature upon the subject of photometry). Pro Age-Nov. 1. 16000 w.

†2309. An Electrolytic Process for the Manufacture of White Lead. R. P. Williams (Description of a process invented in 1892, by Arthur Benjamin Brown, chemist and mining engineer, Boston. The chemical theory as well as the practical aspects of the process are discussed). Jour Am Chem Soc-Nov. 2400 w.

†2310. The Determination of the Heating Effects of Coals. W. A. Noyes, J. R. McTaggart, and H. W. Craver (Analyses of coals from various sources in Indiana. Results obtained with Hempel's calorimeter compared with analyses and with those obtained by Berthier's test). Jour Am Chem Soc-Nov. 1800 w.

2348. The Need of a Good Engineering Library (An editorial on the Brussels Bibliographical Conference the purpose of which was 1st, the foundation of an International Institute of Bibliography, having for its object the study of all questions relating to the science of book knowledge. 2d. The adoption of a universal and international bibliographical classification). Am Eng & R R Jour-Nov. 1. 2000 w.

2349. Pilcher's Flying Machine. Ill. (Description of a machine whereby the inventor has succeeded in rising in the air, and sustaining himself for short spaces, with recent improvements. The machine is more properly a "soaring" than a flying machine). Am Eng & R R Jour-Nov. 1. 200 w.

2369. Dangers of the Sand Blowing Machine and their Removal (Describes the ill effects of the dust in working glass surfaces by the sand blast and methods whereby they may be obviated). Am Mfr & Ir W d-Nov. 1. 700 w.

†2372. On the Growth and Sustaining Power of Ice. P. Vedel (The first number contains the theory of the formation of ice on open water surfaces, rate of formation, and formulæ for computing it, and its strength at various thicknesses). Jour Fr Inst-Nov. Serial. 1st part. 3500 w.

2406 —75 cts. Calorific Determination of the Value of Fuel. George H. Barrus (Paper read before the New England Water Works Asso., Sept. 13. 1895. The purpose of the paper is to show the actual process of making these determinations and to exhibit the action of the apparatus at work. The illustrations accompanying the paper, as printed in the "Journal," replace in part the apparatus for the purpose of the exposition. Discussion). Jour New Eng Water Works Asso-Sept. 1900 w.

*2412. Wheat Smut (Nature and mode of propagation of the smut disease in wheat and other kinds of grain, and methods for its prevention). Am Miller-Nov. 1. 1000 w.

2415. Some Dry-Press Brick Plants. Ill. (An account of brick making by this process. This first part treats of the works of J. L. Burnham and Sons, and the Milwaukee Brick Co.'s yard, both in Milwaukee). Brick-Nov. Serial. 1st part. 2000 w.

2432. The Boston Public Library (Gives interior views, and illustrates and describes mechanism for distributing and delivering books, which is very ingenious and labor saving). Sci Am-Nov. 9. 2000 w.

2442. I. Louis Pasteur. H. W. Conn. II. Pasteur as Illustration of Modern Science. George Bruce Halsted (Interesting reviews of the most important scientific work of Pasteur). Science-Nov. 8. 7500 w.

†2450. Uses and Abuses of Fire and Mill Hose W. H. Adams (Many of the abuses are unavoidable. Suggestions tending to the longevity of hose; causes of depreciation given). Ind Rub Wld-Nov. 10. 2200 w.

†2451. The Earliest Pneumatic Tires. Ill. Hawthorne Hill (Descriptive). Ind Rub Wld-Nov. 10. 1400 w.

†2452. Deterioration of India-Rubber and Its Causes. Frank W. Birchall (Causes determined by patient investigation of physical changes, determined by microscopical examination, and chemical changes studied in the laboratory). Ind Rub Wld-Nov. 10. 1200 w.

†2453. Cable-Laying in the Vicinity of New York (The building of short cables for shallow waters. Their importance and the compounds used in their manufacture. Views of boat used to lay these cables). Ind Rub Wld-Nov. 10. 1100 w.

BOOKS OF MONTH

Circulars further describing the books named in this catalogue may be obtained on application to the publishers.

SPRAGUE, Rev. Franklin M. The laws of social evolution. Bost., Lee & Shepard. 1895. c. 166 pp. D. cl., $1.

ABNEY, W. de W. Color vision: Tyndall lectures delivered in 1894 at the Royal Institution, London. N. Y. W. Wood & Co. 1895. 241 pp. il. 8°, cl., $2.

ATKINSON, Philip. Electricity for everybody; its nature and uses explained. N. Y. The Century Co. 1895. cl. 11+239 p. por. il. D. cl., $1.50.

TAYLOR, T. Wardlaw. The individual and the state. Bost. Ginn & Co. 1895. 90 pp. O. bds., 80c.

KREBS, Stanley L. Poverty's factory. Bost., Arena Pub. Co. 1895. cl. 2-177 pp. S. (Beacon lib. ser., v. 1, no. 4) cl., 75c; pap., 25c.

WARING, G. E., Jr. How to drain a house: practical information for householders. 2d ed., with annotations. N. Y. D. Van Nostrand Co., 1895. cl. 6+223 pp. il.

ASHLEY, Ossian D. Railways and their employees. Chic. The Railway Age and Northwestern Railroader. 1895. cl. 213 p. D. buckram, $1.

RICHARDS, Jos. W. Aluminium: its history, occurrence, properties, metallurgy, and applications, including its alloys. New ed., rev. and enl. ed. Phil. H. Carey Baird & Co. 1895. 700 pp. 8°, cl., $6.

PETERS, E. T. The monetary standard. Wash., D. C., The Economic Publishing Agency. 1895. c. 24 pp. O. pap., 10c.

PLATT, C. Laboratory notes in qualitative analysis and medical chemistry. Phil. J. Jos. McVey. 1895. c. 2-108 pp. O. cl., $1.50.

WRIGHT, L. A popular handbook to the microscope. N. Y. and Chic. Fleming H. Revell Co. 1895. 256 pp. il. 12°, cl., $1.

BARTLETT, Edwin J. Laboratory exercises in chemistry. Bost. Leach, Shewell & Sanborn. 1895. cl. 2-113 pp D. bds., 50c.

BONNEY, T. G. Charles Lyell and modern geology. N. Y. Macmillan & Co. 1895. 224 pp. por. D. cl., $1.25.

GIBBONS, H. de B. The industrial history of England. 4th ed. N. Y. imported by C. Scribner's Sons. 1895. 240 pp. maps, 12°, (University extension ser.) cl., $1.20.

CONNOR, D. E. A treatise on electro-magnetism. Lynn, Mass. Bubier Pub. Co. 1895. cl. 73 p. il. T. bds., 50c.

BRIGGS, Rob. Steam-heating. New ed., rev. and enl., with additions by A. R. Wolff. N. Y., D. Van Nostrand Co. 1895. 16°, (Van Nostrand's science ser., no. 68.) bds.

RAFTER, G. W. Mechanics of ventilation. New and rev. ed. N. Y. D. Van Nostrand Co. 1895. 16°, bds., 50c.

WATSON, A. E. How to build a fifty-light dynamo or four horse-power motor; il. with working drawings. Lynn, Mass. Bubier Pub. Co. 1895. cl. 38 pp. sq. S.

WRIGHT, T. W. A text-book of mechanics for colleges and technical schools. New and rev. ed. N. Y. D. Van Nostrand Co. 1895. 12°, cl., $2.50.

SMITH, Richmond Mayo. Statistics and sociology. N. Y. Macmillan & Co. 1895. cl. 16+399 pp.

TAIT, P. G. Dynamics. N. Y. Macmillan & Co. 1895. 12°, cl., $2.50.

TREVERT, E. Electricity for students. Lynn, Mass. Bubier Pub. Co. 1895. c. 3-128 p. il. sq. S. cl., $1.

STEWART, Balfour. An elementary treatise on heat. New 6th ed. rev., with additions, by Rob. E. Baynes. N. Y. Macmillan & Co., 1895. 12°, cl., $2.25.

BOOKS RECEIVED.

AUCHINCLOSS, William S., C. E. Link and valve motions; 13th edition. New York. D. Van Nostrand Co. 1895. cl. 138 pp. 6″×9″, $2.00.

GRAFTON, W. McC., C. E. Railway Signaling. Madison, Wis. Published by the University. 1895. pap., 184 pp., 6″×9″.

SMITH, Leonard Sewal, B. C. E. An experimental study of field methods which will insure to stadia measurements greatly increased accuracy. Madison, Wis. Published by the university. pap., 145 pp. 6″×9″.

RAYMOND, Maj. C. W., Corps of engineers U. S. A. Flood protection of the city of Williamsport, Pa. Williamsport, Pa. Press of The Gazette and Bulletin. pap., 72 pp. 6″×9″.

CONSULAR reports Vol. XLIX, No. 181. Commerce, manufactures, etc. Washington Govt. Printing Office. Oct. 1895. pap., 256 pp.

LEYPOLDT, Augusta H., and ILES, George. List of Books for Girls and Women and their clubs. Boston Library Bureau. 1895. 161 pp. 7″×10″. cl., $1.00; pap., 50cts.

BIRKINBINE, John. The production of iron ores in various parts of the world. Washington, Govt. Printing Office, 1895. 204 pp. 7¾″×11¼″.

GOULD, E. R. L., Ph. D. The housing of the working people. Eighth special report of

the commissioner of labor. Washington. Govt. Printing Office. 1895. cl., 461 pp. 6″×9″.

WHEELER, H. A., E. M. Vitrified Paving Brick. Indianapolis, Ind. T. A. Randall & Co. 1895. pap., 84 pp. 5½″×8″. $1 00.

CAMPBELL, Frederick A., C. E. Notes and tables relative to the strength of materials. Melbourne, Australia. Published by the author. pap., 20 pp. 18d.

RULES and list of members of the Iron and Steel Institute. London. Published at the offices of the Institute. 1895. pap., 104 pp. 5¼″×8½″.

BIRKINBINE, John. The production of iron ores in various parts of the world. Washington, Govt. printing office. 1895. pap., 204 pp. 7¾″×11¾″.

MOORE, Willis L., chief of weather bureau. Monthly weather review, March, 1895. Washington, Weather Bureau. 1895. pap., 116 pp., 8″×12″, with nine infolding charts.

RAFTER, George W., C. E. Report on moveable bridges used in Europe. Albany. James B. Lyon, printer. 1895. pap., 29 pp. 6″×9″, with numerous unpaged plates.

FROUGH, Bennett H., Secretary. The Journal of the Iron and Steel Institute. London and New York. E. & F. N. Spon. 1895. cl., 571 pp. 5¼″×8¼″.

WAKEMAN, W. H. Modern examinations of steam engineers. Bridgeport, Conn. American Industrial Publishing Co. 1895. cl., 272 pp., 5¼″×7¾″.

ABBOTT, Arthur Vaughn, C. E. The electrical transmission of energy. New York. D. Van Nostrand Co. 1895. c., 586 pp., 6″×9″.

TRANSACTIONS of the American Society of Heating and Ventilating Engineers. First annual meeting Jan. Published by the society. New York. 1895. cl., 259 pp., 6″×9″.

PARKER, Edward Wheeler. The production of coal in 1894 Washington. Govt. printing office. 1895. pap., 224 pp., 8¼″×11¼″.

MOORE, Willis L., chief of weather bureau. Monthly weather report, May, 1895. Washington. Weather Bureau. 1895. pap., 197 pp. and charts.

WARING, Geo. E. Jr., M. Inst. C. E. How to drain a house. Second edition, with annotations. New York. D Van Nostrand Co. 1895. cl., 223 pp., 4⅝″×6⅞″. $1.25.

HOUSTON, Edwin J., Ph. D., and KENELLY: A. E., Sc. D. Alternating electric currents. New York. The W. J. Johnston Co. 1895. cl., 225 pp., 5″×6½″. $1.00.

PENCE, Prof. Wm. D., C. E. Stand-pipe accidents and failures, with illustrations and tables. New York, Engineering News Publishing Co. 1895. pap., 195 pp., 4¾″×5¾″. $1.00.

FREITAG, Joseph Kendall, B. S., C. E. Architectural Engineering. New York. John Wiley and Sons. 1895. 239 pp., 6″×9″. $2.50.

COMSTOCK, William T. The architects' directory. New York. William T. Comstock. 1895. Flexible cover. 108 pp., 5″×6¼″. $1.00.

HARROP, Herbert B. and WALLIS, Louis A. The forces of Nature. Columbus, Ohio. Harrop & Wallis. 1895. cl., 159 pp., 5¼″×7⅛″. $1.25.

BALDWIN, James, Ph. D. A guide to systematic readings in the Encyclopædia Britannica-Chicago–New York. The Werner Co. 1895. cl., 316 pp., 5¼×7¼.

WARMAN, Cy. Tales of an Engineer. New York. Charles Scribner's Sons.

RICHARDS, Frank. Mem. A. S. M. E. Compressed air, air-compression and the transmission of compressed air. New York. John Wiley and Sons. 1895. cl., 203 pp., 5″×7¼″.

U. S. DEPARTMENT of Agriculture. The world's markets. Washington. Government printing office. 1895. The German Empire. 91 pp., 6″×9″. France. pap., 74 pp., 6″×9″. Great Britain and Ireland. pap., 155 pp., 6″×9″. Canada. pap., 67 pp., 6″×9″.

ELGAR, Francis, LL. D., F. R. S. E., late director of H. M. dockyards. The cost of warships. London. Institution of Naval Architects. 1895.

AMERICAN Institute of Electrical Engineers. Transactions for 1894. Vol. XI. New York. Published by the institute. 1895. cl., 938 pp., 6″×9″, with folding chart, entitled Diseases of Dynamos.

BENJAMIN, Park, Ph. D. L.L. B. The intellectual rise in electricity. New York. D. Appleton & Co. 1895. cl., 611 pp., 6″×9″.

BOOK NOTICES.

PROCEEDINGS OF THE 28TH ANNUAL CONVENTION American Institute of Architects, held in the Fine Arts Building, New York, October 15, 16, and 17, 1894. Published by the Board of Directors, A. I. A. under direction of the committee on publication and library, Alfred Stone, editor Providence: E. A. Johnson & Co., printers, 1895. [225 pp., 7″×9½″. Flexible covers].

This volume of proceedings is of more than ordinary interest.

THE TUTORIAL PHYSICS. VOLUME II. A TEXT-BOOK of Heat, with numerous diagrams and examples. By R. Wallace Stewart, D. Sc., London, first-class analyst in physics at B. Sc.; author of "An Elementary Text Book of Heat and Light," and "Elementary Text Book of Magnetism and Electricity," etc., etc. London: W. B. Clive, University Correspondence Press New York: 65 Fifth avenue. [294 pp., 4½″×6¼″.]

The same merits that have characterized the previous volumes of this series are manifested in the work under notice. The introductory matter abridging the mathematical consideration of the laws of heat is exceedingly well written. The mathematical formulæ are reduced to very simple operative forms, and the examples given

are extremely well prepared with a view to the application and illustration of the formulæ. Considerable attention is paid to graphic methods, especially in that portion of the book which is devoted to thermo-dynamics. As a text book in schools this book will fill a very useful place.

NYSTROM'S POCKET BOOK OF MECHANICS AND ENGINEERING, revised, corrected, and greatly enlarged, with addition of original matter, by William Dennis Marks, Ph. B., C. E. (Yale S. S. S.) 21st edition further revised and corrected by Robert Grimshaw. Philadelphia: J. B. Lippincott, 1895. [674 pp., 4″ × 6½″. Morocco, price $3.50.]

It is scarcely necessary to make any remarks regarding this long-known and widely-used collection of data for the use of engineers, the title being sufficiently descriptive. The work has always been regarded as authoritative, and most of the data given have been found remarkably accurate. The same care that was bestowed upon the preparation of the book in the first edition by the eminent author has been bestowed in the revision and addition of original matter.

CHEMICAL ANALYSIS OF OILS, FATS, WAXES AND OF the Commercial Products derived therefrom, from the journal of Dr. R. Benedikt, revised and enlarged by Dr. J. Lewkowitsch, F. I. C., F. C. S., Technical manager of the Whitehall Soap Works, Leeds, Consulting Chemist and Chemical Engineer. London: Macmillan & Co., New York, 1895. [683 pp., 6″ × 9″. Cloth price, $7.00.]

The author tells us in his preface that, as there has not been, hitherto, a book dealing especially with the chemical analysis of oils, fats and waxes, he was on the point of writing one, when he was asked by Prof. Benedikt to render his German work, "*Die Analyse der Fette und Wachsarten*" into English, with such alterations as he thought necessary. Prof. Benedikt's book being undoubtedly the best on that subject, Dr. Lewkowitsch thought that instead of adhering to his original intention to write a book, it would be more useful to found upon Prof. Benedikt's book an English edition; he has therefore, translated, revised and enlarged the German work. Very numerous additions have been made and alterations are noticeable in nearly every page, the object being to abridge or leave out entirely obsolete processes, and to arrange the subject matter with reference to present practical requirements. Several chapters have been almost entirely re-written and a special feature is the tabular form adopted for the constants for the individual oils, fats and waxes. The work has been enlarged by devoting more space to the English and American chemists than was found in the original German publication. The descriptions of technical processes have been compressed in narrower limits, but those points which give the analysist the necessary clue to the lines to be adopted in the course of analysis have been emphasized. An apparently successful attempt has been made to amalgamate scientific accuracy with practical knowledge.

EXAMINATION OF WATER FOR SANITARY AND TECHnique Purposes. By Henry Leffman, A. M., M. D., Ph. D., Professor of Chemistry in the Woman's Medical College of Pennsylvania, in the Pennsylvania College of Dental Surgery and in the Wagner Free Institute of Science; Pathological Chemist to the Jefferson Medical College Hospital; Chemist to the Dairy and Food Commissioner of Pa. Third edition, revised and enlarged, with illustrations. Philadelphia: P. Blakiston, Son & Co., 1895. [154 pp., 5″ × 7″. Cloth, price, $1.25.]

The general character of treatment has been preserved in this edition, but numerous modifications of the details of processes of sanitary analysis, as developed by various American workers, are described and discussed. The State stations for sanitary control have contributed much valuable matter to sanitary science within a few years, and this has been a source from which important additions to the original treatise have been selected.

Much of the matter has been re-written and sources of uncertainty which were pointed out in earlier editions, and, within the last few years, have become much more appreciable to the profession at large, have been treated more at length. The section on biological examinations has been considerably extended. Some of the processes for purification of water are described in detail.

EXPERIMENTS WITH A NEW POLARIZING PHOTOChronograph Applied to the Measurement of the Velocity of Projectiles. By Dr. Albert Cushing Crehore, Assistant Professor of Physics, Dartmouth College, and Dr. George Owen Squire, 1st Lieutenant, 3d Artillery, U. S. A. Reprinted from the Journal of the U. S. Artillery. Volume IV. No. 3. Artillery School Press, Fort Monroe, Va., 1895. [Pamphlet, 42 pp., 6″×9″ and 22 half tone plates.]

Gives an account of a very interesting instrument and experiments with it, at the U. S. Artillery School at Fort Monroe,

between the dates of the 27th of December, 1894, and the 12th of January, 1895. The diagram illustrating the results shows a probability that the record made by a break in the current by the passage of the projectile is sharp and well defined, and that it will permit of an accuracy in reading the record even beyond that attainable by measuring the intervals between screens on the proving ground.

A BRIEF REVIEW OF RAILROAD HISTORY FROM THE Earliest Period to the Year 1894. By W. Hasell Wilson, Honorary Member, Society of Civil Engineers. Philadelphia: Allen, Lane & Scott, 1895. [53 pp., 5″×7½″.]

A re-presentation of a story that has been told many times in different forms by other authors; so far as we can discover no new light has been thrown upon the subject.

STATIONARY ENGINEERS' GAZETTEER OF ILLINOIS, containing a complete list of chief engineers of all steam plants in Illinois; names of the officers; location and night of meeting of all Stationary Engineers' Associations in Illinois; also, list of supply houses, with telephone numbers and other information of interest to the craft. Chicago Stationary Engineers' Gazetteer Association, 159 La Salle Street, Room 3. [136 pp., 8″ × 10½″. Paper, price, $10.]

This appears to be a very complete and reliable directory of the Stationary Engineers of the entire State of Illinois. The work contains an accurate list of chief engineers in charge of blocks, buildings, hotels, club houses, manufacturing plants, flats, packing houses, breweries, apartment houses, etc., together with a list of engineers' supply houses and their telephone numbers. A supplement to the list of engineers contains a full and correct enumeration of the make and capacity of the engines, boilers, pumps, dynamos, electric lights, and elevators under the supervision of each engineer. A table giving the most direct route of shipment to any part of the State is appended.

BOILER ENGINEERING, BEING INTERESTING AND Instructing examples in civil, mechanical, electrical, chemical, mining, military, and naval engineering, graphically and plainly described and specially written for those about to enter the engineering profession, and the scientific amateur: with chapters on perpetual motion and engineering schools and colleges. By F. Dye, London: E. and F. N. Spon, New York: Spon and Chamberlain, 1885. [476 pp., 7″ × 9¼″. Cloth, price, $3.00.]

This book is written in popular style, and deals only with the most prominent outlines of the different subjects. It is not intended to be a thorough treatise on any of the subjects named, but to furnish to non-technical readers, and to those entering upon any of the branches of engineering named, a general idea of the nature of the work they will be called upon to perform.

AMERICAN STEAM VESSELS. BY SAMUEL WARD Stanton. New York: Smith & Stanton, 1895. [496 pp., 8″ × 12″. Handsomely bound in cloth with gilt edges, price, $5.00.]

Claimed to be the first collection of its kind ever published. A handsome volume, containing illustrations and descriptions of almost all known types of successful steam vessels that have been constructed in the United States, and also the famous and historical vessels of the early days and of our own time. The arrangement of the illustrations is chronological; the chief aim has been to secure accuracy. Illustrations of earlier steamers have been taken from wood cuts, drawings, or paintings, while illustrations of the later boats have been produced from photographs, plans, sketches, etc. There are eight hundred and seventeen illustrations in all, making a decidedly unique collection. The portraits, corners, etc., of the pages are printed in different colors, giving a very artistic effect.

ARCHITECTURE FOR GENERAL READERS. A SHORT Treatise on the Principles and Motives of Architectural Design. With a Historical Sketch. By H. Heathcote Statham, Fellow of the Institute of Architects; Editor of *The Builder*. New York: Imported by Charles Scribner's Sons. [348 pp., 8 1-2″ × 5 1-2″. Price, $3.50.]

Brief, well written, amply illustrated and dealing with topics the general reader should be acquainted with, this book fills a space no other book yet occupied, in architectural literature. The first part is devoted to a series of interesting, general essays, on the fundamental principles of architecture. The topics chosen in this part are well selected, and well treated. The author insists through out that architecture is more than the arrangement of certain materials and ideas according to rule, and that such things have little place in its history. This view is presented in a popular but philosophical manner certain to meet approval.

The second part contains a historical sketch of architecture, in which he rightly traces the evolution of the art continuously from the Egyptian to the renaissance. Through necessarily brief, the chief elements of the different styles are graphically presented, and the general reader will find here a portrayal of the leading movements in the history of architecture as a basis of further study. The book is brief, but a very wide range is covered in its well-printed pages. To many its brevity will be an added advantage. Just such a book as this has long been needed, and its author is to be congratulated for carrying out his work in so able a manner. This, indeed, was to be anticipated, his long experience as editor of *The Builder* having giving him the advantage of being able to gage the public mind in every way. Moreover, he has been enabled to see, as perhaps few have seen, the faults of existing works that profess to instruct the public and the profession of architecture. Not the least interesting fact in connection with this charming book is that its author is a practising architect. We commend the book both to architects and general readers.

HENDRICKS' ARCHITECT'S, BUILDER'S, AND CONTRACTORS' Directory of America for builders contractors manufacturers, and dealers in all kinds of building supplies. For 1895 and 1896. New York: Samuel E. Hendricks Co. [832 pp., 6¼″ × 10″. Cloth, price, $5 00.]

This is claimed to be a complete directory of all the construction industries of the country, containing over 200,000 names and business classifications, comprising builders and contractors for material and construction in the building and kindred trades. It also contains full lists of the manufacturers of, and dealers in, everything employed in the manufacture of materials and apparatus used in these industries, from the raw material to the manufactured articles, and from the producer to the consumer. A complete index is provided, whereby any occupation in which the name is sought may be turned to at once. The places of residence are in capitals, which renders the research very easy. A valuable book of reference.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Farrel Foundry and Machine Co., Ansonia, Conn., U. S. A.=Catalogue A, 2d edition, 48 pp., 7¼″ × 9¾″. [Describes and illustrates the Farrel and Bacon ore- and rock-crushing machinery manufactured by the company named; also revolving screens, elevators, conveyors, road railways, &c. The company is represented by Earle C. Bacon, engineer, Havemeyer Building, 26 Cortlandt street, New York.]

Clayton Air Compressor Works, Havemeyer Building, New York, U. S. A.=Pamphlet, 86+XIV pp., 8″ × 10½″. [Describes and illustrates the Clayton Air Compressor; also discusses the widening use of compressed air in an article reprinted from the ENGINEERING MAGAZINE; gives complete directions for erecting and operating the Clayton Air Compressors, and suggestions for ordering duplicate parts, and describes and illustrates vertical and horizontal tubular boilers, with price list; gives in addition, as a history of success, a long list of testimonial letters.]

Lane Foundry and Machine Works, Huntingdon, Pa., U. S. A.=Catalogue, 1895, 26 pp., 4″ × 7″. [Describes and illustrates throttling, automatic, vertical, horizontal, hoisting, stationary, and portable engines, and vertical, horizontal, tubular, locomotive, and portable boilers.]

Hilles and Jones Co., Wilmington, Del., U. S. A.=Catalogue, 1895, 32 pp., 12″ × 9″. [Describes the line of machine tools for the equipment of iron shipyards, boiler shops, bridge works, and car and locomotive works, together with special machines for working plate and shape iron.]

The Hunt Air Brake Co., Pittsburg, Pa., U. S. A.=Instruction book for the maintenance and handling of the Hunt Air Brake system. 56 pp., 5″ × 6½″. [Pocket inside cover contains a plate illustrating the Hunt Air Brake system as applied to heavy, double truck electric cars, and a card illustrating the three-way valve employed in this system, with transparent revolving slip by which the operation of the valve in all positions may be easily comprehended.]

J. T. Slocomb and Co., Providence, R. I., U. S. A.=Catalogue, 16 pp., 6″ × 9″. [Describes and illustrates with price list a line of machinists' bench tools, including micrometer gages and calipers, combination indicators, combination center drills, and outside micrometer calipers, with directions for use; also describes a patented standard revolution counter, which registers two thousand revolutions and is constructed upon the principle of the stop-watch.]

For additional catalogues see page 600 under Improved Machinery.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Lundell Exhaust Fan Outfits.

THESE combined exhaust fans and motors are made in sizes ranging from ¼ h. p. to 15 h. p. in the motors and from 18 in. diameter to 72 in. diameter of fan, the 18-in. fan running at 1000 revolutions, and the 72-in. fan running at 350. The design of the Lundell electric motor is well adapted to attachment to any of the standard

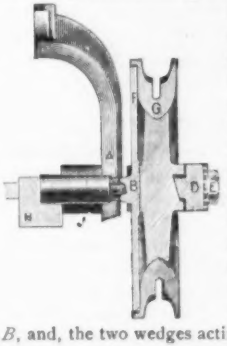
LUNDELL EXHAUST FAN.

makes of exhaust fans, the cost of attachment, exclusive of the price of the motor, ranging from $42 for 18-in. fans to $200 for 72-in. fans. Contrary to the usual practice of manufacturers, instead of one bearing at the front and another at the back of the fan, the shaft has two bearings in the motor frame itself, the shaft not being supported in any sense from the fan ring. With either horizontal or vertical shafts this insures perfect alignment and noiseless running. This combined fan and motor (manufactured by Interior Conduit and Insulation Co., 527 West Thirty-fourth street, New York) has other desirable features. With all their standard horizontal shaft fans, an adjustable thrust bearing—shown in the cut—is provided. When the flow of air is desired contrary to the standard direction, a button and thrust bearing is placed at the rear of the motor. Provision for oil lubrication is made for all the horizontal fans. In the vertical ones the step at bottom is lubricated with oil, and the upper end of the shaft runs in a graphite bearing. The standard motors run with currents of 115 volts, but motors are wound for 230- and 500-volt circuits.

Automatic Brake for Differential Chain Pulley Block.

THIS ingenious device which is a feature of the Moore's antifriction differential chain pulley blocks manufactured by the Moore Manufacturing Co., Milwaukee, Wis., is illustrated in the accompanying cut.

A friction plate *F* of slightly less diameter than the hand wheel is mounted upon an extension of the hub of the hand wheel and between it and the block frame *A*. The friction plate has a wedging con act with the block frame at *B*, and the hand wheel has a reverse wedging contact with the clutch *D* which is keyed to the shaft and held in position by the adjusting nut *E*. A pull on the hand chain to raise the load loosens the wedge *B* and tightens the wedge *D*, while a pull on the hand chain to lower the load tightens the wedge *B*, but loosens the wedge *D*, one wedge counteracting the other and producing no friction between the plate and the frictional surface of the wheel at the point *F*. But when the hand wheel *G* is in a state of inertia, the pull of the load on the shaft tightens the wedge *D* carrying with it the hand wheel and friction plate, tightening also the wedge *B*, and, the two wedges acting together, set the frictional surfaces into contact and effectually lock the block. A pull on the hand chain in either direction releases one of the wedges, but as soon as the pull ceases the load instantly

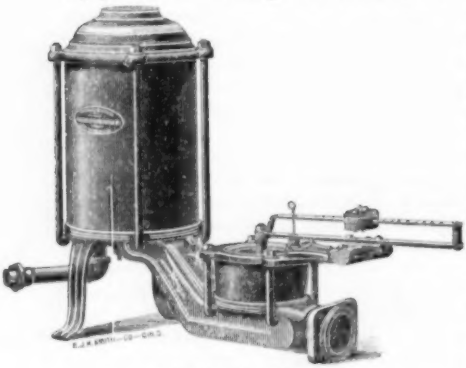


catches up and locks both of them. The lock is positive and smooth working, since the friction surfaces are really never out of contact, and heavy loads may belowered by a pull on the chain of a very few pounds.

The Rife Hydraulic Ram.

IT is a remarkable fact that from 1796, the date of Montgolfier's improvement upon the hydraulic ram, up to 1887 there had not been the slightest improvement in this device, notwithstanding that thousands of them have been sold and made by the largest pump concerns in the world. These manufacturers repeatedly endeavored to build large rams, but being unable to feed air to them these machines were invariably pounded to pieces from concussion.

In 1887, an American inventor, Mr. W. A. Rife, of Waynesborough, Virginia, invented, designed, and patented the "Rife" ram, which is supplied with air automatically, by means of a peculiar construction of the base, thus enabling him to build the "Rife" ram to any required capacity and fill a long-felt demand long felt, by placing on the market a ram admittedly the only practical air-fed large ram in the world.



RIFE HYDRAULIC RAM.

These rams are used in elevating water for irrigation, and for supplying small towns, railroad tanks, colleges, etc., etc., as well as all smaller demands.

Another improvement due to Mr. Rife is that, through the use of a common check-valve, the ram becomes double acting and will deliver one kind of water while using another water as power; and, as the two waters cannot possibly mix, this improvement is of especial value. There are many springs so small or weak that they cannot furnish the power to run even the smallest ram, but, by the use of the "Rife" improved ram, muddy or branch water can be used as power to deliver pure spring water. The rams are in such cases guaranteed to deliver only the spring water.

At the World's Fair in Machinery Hall one of these rams was in constant operation, delivering seven thousand gallons per hour, as is claimed, at a cost of *less than two cents a day!* The Rife ram received the highest awards, medals, and diplomas, over all competitors at this great exposition. The Power Specialty Co., 126 Liberty street, New York, are supplying these excellent machines and may be addressed for further particulars.

Translucent Fabric.

THIS new material is steel wire cloth covered with a semi-transparent, impervious material. It is evident, upon inspection of a sample, that it will be found adapted to many uses. It is, strong, durable, non-inflammable, a non-conductor of heat, light, and cheap. It is adapted to use in sky-lights, roofs, windows, train-sheds, greenhouses, hot-houses, translucent partitions, office doors, and other uses. The material in which the reinforcing web of wire cloth is embedded is a peculiar chemical substance claimed to be as durable as any known elastic substance. Neither heat or cold, rain, snow, hail, or sleet affect it. Hot coals, cinders, etc., falling upon it will not ignite it. It is weather-proof, perfectly flexible, and as translucent as skylight glass. Its non-conducting quality helps to keep a building warm in winter and cool in summer. Its weight is only from $\frac{1}{3}$ to $\frac{1}{15}$ that of glass, depending upon the thickness of the fabric. We are informed by the manufacturers, Translucent Fabric Co., 64 Federal street, Boston, Mass., that this new material is meeting with unqualified appreciation among architects, builders, and engineers, and that many representative firms are using it in preference to glass for purposes to which it is adapted. The skylight roof of the monitor running the entire length of the new forge shop of the Berlin Iron Bridge Co., at East Berlin, Conn., is of this material, and the president of that company, Mr. Charles M. Jarvis, testifies strongly to its merits.

THE greatest record of the year in the output of the Homestead, Pa., Steel Works, was made in October, when every department of the immense plant, without a single exception, made the largest output in any one month of the history of the plant. In beams and channels the output was 19,600 tons and the 119-inch plate mill turned out 8537 tons.

Heating and Ventilation in the High School, Arlington, Mass.

THE heating and ventilating plant placed in the above-named school by Messrs. Smith, Anthony & Co., of Boston, Mass. (being the system of apparatus manufactured by the Huyett and Smith Manufacturing Co. of Detroit, Mich.), having been examined and inspected by Mr. Joseph A. Moore, Massachusetts State inspector of public buildings, the inspector reported to the chief of Massachusetts district police, the chief in turn transmitting the report to the chairman of the building committee of the school.

"RUFUS R. WADE, ESQ.,

"Chief Inspector and Chief of Massachusetts District Police:

"SIR,—In accordance with your instructions given at the request of the chairman of the new Arlington high school building committee, I have, in company with Inspector John T. White, made a careful inspection of the ventilation of said building.

"In the eight school rooms there are possible accommodations for 352 scholars. The supply of air in these rooms averaged 48.8 cubic feet per minute for each of the 352 scholars. The amount of air exhausted by the vent-ducts averaged 52 cubic feet per minute for each scholar that could be accommodated. The number of pupils at present in the building is very much smaller than the number of seats. The amount of air supplied in the hall in the third story was 5473 cubic feet per minute, taken with the air ducts open into all the other rooms. With the ducts to the other rooms partly closed, the supply was 10,654 cubic feet per minute.

"Two tests of the purity of the air in the master's room, with forty pupils present, made at quarter past twelve o'clock, gave 4.9 and 5 parts of carbonic acid in 10,000 parts of air. The outside air containing 4 parts of carbonic acid in 10,000 of air, it will be seen that the inside air was nearly as pure as that outside. The hallways and corridors were all warm, and the air was first-class. The sanitary closets were in first-class condition, well ventilated, and no disagreeable odors could be found.

"The amount of fresh air supplied and foul air exhausted was fully up to all the requirements of first-class ventilation. The temperature in different parts of the several rooms was very even, and the circulation of the air was first-class.

"I consider this one of the very best ventilated school buildings in the State."

At the same time the following report of Mr. Thomas Hawley, State inspector of boilers, was transmitted to the chairman of the building committee by Chief Wade:

"RUFUS R. WADE, ESQ.,

Chief District Police, Boston, Mass.:

"DEAR, SIR—I have inspected the boilers and heating apparatus at the Arlington high school, and report as follows: The two boilers are known as the "Star water tube," and each consists of an internal fire box with water tubes crossing the furnace. From an external inspection, the boilers appear in good condition, and, as constructed, are efficiently braced, and provided with all the fittings necessary to safety, and well arranged. The boilers are amply large enough to heat and ventilate the building in zero weather, and the steam plant as a whole is a safe and excellent one, and well set up."

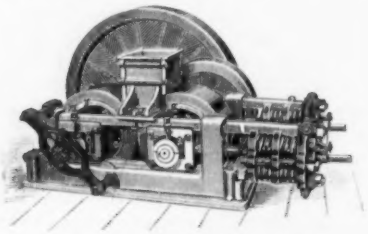
Such reports as these must be extremely flattering, both to the manufacturers of the apparatus and to the contractors who placed it in the building.

Improved Ore Crushing Rolls.

THE Colorado Iron Works of Denver, Colorado, have introduced important improvements in rolls for ore crushing, commonly known as "Cornish Rolls." Rolled steel tires only are used, and are claimed to be the best in use. The frames are made in one solid massive casting, making the machine rigid and self-contained, thus insuring permanent alignment of the various working parts. The universal boxes of these rolls, as designed and applied by Mr. Franz Cazin, are pivoted in guide frames in such manner as to always conform to the shafts, however much one side of the rolls may be fed more than the other. A bar or other heavy piece of iron or steel may pass by accident between the rolls near one end, thus spreading the rolls apart at that end an inch or two, and still throw no excessive strain on the box or the shaft, as the box is pivoted on trunnions in the sliding box frame, and remains in line with the shaft.

A very complete device, also of Mr. Cazin's designing, keeps the end adjustment of the rolls exact, which is a most important feature not heretofore provided for. It is the universal experience that after rolls have run awhile, one or other of them begins to wear endwise against one of the boxes, and soon they are not exactly opposite, that is, they overlap each other at the ends, which trouble grows worse every day as they wear down, leaving a high ridge or flange

on opposite ends of the two rolls, and when this happens nothing can be done to stop the trouble but to send them to the shop to be turned down parallel again. With the device adopted it takes but a moment to bring the two rolls opposite each other when they begin to wear away, and the evil is corrected at once.



IMPROVED ORE CRUSHING ROLLS.

Heavy wrought-iron guide bars are applied both above and below, and the universal box frames are carried and guided by these bars, which also extend through the corner posts of the main frames, and at one end carry the springs on the two sides of the machine.

The springs are carried in frames or cages on the two sides of the machine at one end, each side entirely independent of the other, and these springs are put in place under a pressure of eight to eighteen tons, depending on size of machine, on each side. This arrangement of the springs is a most important one, in that the rolls are held in relative positions under 16 to 36 tons pressure, and there is no movement apart or away from each other in ordinary work. Only when some pieces of iron or steel, as a bar, or gad, or pick point, passes through, this pressure is exceeded, and the springs yield and let the obstruction through, and the rolls at once reassume their proper relative position automatically. Thus there are less fines, and less coarse lumps than pass through rolls of ordinary construction, and the jiggling and consequent wear of the boxes in the guides is entirely avoided.

The rolls are housed in completely, which obviates the wasteful and disagreeable nuisance of dust. Where housings are not required, as in sampling mills, the hoppers are bolted by suitable clamps and flanges to the top guide bars, by which bolts and nuts are made easy of access, and the hopper can be removed entirely in a minute. The best material and workmanship are employed in these machines.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Naylor Bros., Peekskill, N. Y., U. S. A.=Catalogue, 64 pp., 4¼″ × 7″. [Describes and illustrates a line of pulleys, hangers, shafting, and power-transmitting machinery, with price list.]

Jenkins Bros., New York, U. S. A.=Catalogue, 68 pp., 7½″ × 5″. [Describes and illustrates a full line of globes, angle and cross valve, wood wheel radiator valves, gate valves of the well known "Jenkins" trade mark, made with iron or steam-metal bodies, and also the Jenkins standard packing with price list, etc.]

The Rife Hydraulic Engine Manufacturing Co., Roanoake, Va., U. S. A., and Pacific Department, San Francisco, Cal., U. S. A.=Pamphlet, 35 pp., 3¼″ × 5⅜″. [Describing and illustrating the Rife Automatic Hydraulic Engine or ram for irrigation, water supply of small towns, railroad tanks, factories, steam mills, dairies, country residences, stock yards, etc.]

Irvin Van Wie, Syracuse, N. Y., U. S. A.=Catalogue, 48 pp., 6¾″×10″. [Describing centrifugal and triplex pumps manufactured at the Baldwinsville Centrifugal Pump Works, of which Mr. Van Wie is the proprietor.]

Davis-Farrar Co., Engineers, Erie, Pa., U. S. A.=Catalogue, 24 pp., 9″×6″. [Describing and illustrating centrifugal pump machinery, single, compound, and triple-expansion marine and stationary engines and boilers.]

Follansbee Bros. Co., Pittsburgh, Pa., U. S. A.=Memorandum book, 3″×6″. [Blank, except covers, which contain the advertisement of the sheet iron, roofing iron, tin and terne plates, tools, and machines manufactured by this company.]

The Columbian University, Washington, D. C., U. S. A.=Catalogue for academic year, 1895, 199 pp., 5″×7½″.

William Cox, Civil Engineer, Stapleton, N. Y., U. S. A.=Leaflet, 4 pp., 6″×9″. [Describes and illustrates a mechanical device designed to solve, by means of Kutter's well-known, but complicated formula, problems relating to the flow of water in pipes, and, to a considerable extent, in open channels.]

Stover Manufacturing Co., Freeport, Ill., U. S. A.=Pamphlet, 64 pp., 6″×9″. "Irrigation." [Describes and illustrates the "Ideal" wind-mill with list of sizes, capacities, and prices.]

†1740. Notes on Water Gas. George Ritchie (Paper presented to the West of Scotland Iron & Steel Inst. A description of two continental gas plants, at Essen and Berlin, used for metallurgical purposes, and for heating and lighting at Hamburg). Ind & East Eng–Aug. 31. 1800 w.

For additional catalogues see page 596 under Books of the Month.